Aviation Week and Space Technology

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A McGraw-Hill Publication

January 9, 1961

West Germans Stress Jet Pilot Training

THE UNIVERSITY OF MICHIGAN
ENGINEERING

Piper Four-Place Cherokee

ANOTHER ASPECT OF THE MARQUARDT MISSION

LIFE SUPPORT IN SPACE –

An Independent Research Project by The Marquardt Corporation

Man now lives in an environment to which he has adapted himself and which to some extent has learned to control. Thus, the manned space exploration program on the verge of becoming a reality must eventually provide a closed ecological system—an earth-oriented, miniature world—so astronauts can survive, function and fulfill their missions in the hostile environs of deep space.

ASTRO, Marquardt's division for research into the space age, is actively engaged in an extensive Bioastronautics program of applied research to solve many of these physiological and psychological problems.

One basic physiological project is directed towards photosynthetic gas exchangers. Various algae forms are being used to effect the conversion of carbon dioxide to life-sustaining oxygen and food for the duration of the space voyage—a period that may last from a few weeks to a few years.

The creation of a capsule-sized ecological system to sustain man in space, only one of the many objectives of the independent research program underway at ASTRO, serves to typify yet another aspect of The Marquardt Mission.

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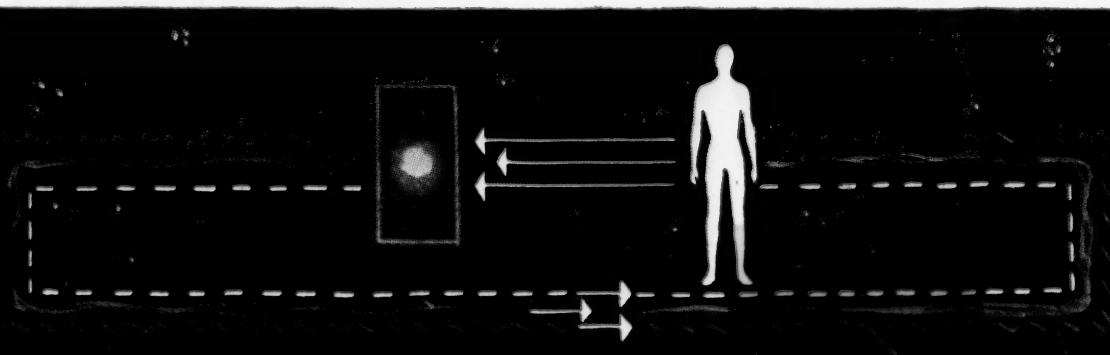

AVIATION CALENDAR

Jan. 16-18—Seventh Annual National Meeting, American Astronautical Society, Dallas, Tex.

Jan. 17-19—Winter Instrument-Automation Conference & Exhibit, Instrument Society of America, Jefferson Hotel and Kiel Auditorium, St. Louis, Mo.

Jan. 23-24—Annual Meeting, Assn. of Local Transport Airlines, National Aviation Club, Washington, D. C.

Jan. 23-25—29th Annual Meeting, Institute of the Aeronautical Sciences, Hotel Astor, New York, N. Y. Honors Night Dinner, Jan. 24.

Jan. 28—Institute of Navigation's Western Regional Meeting, California Institute of Technology, Pasadena, Calif.

Feb. 1-3—Second Winter Military Electronics Convention, Institute of Radio Engineers, Biltmore Hotel, Los Angeles.

Feb. 1-3—Solid Propellants Conference, American Rocket Society, Salt Lake City.

Feb. 14-16—Second Annual Symposium on Non-destructive Testing of Aircraft and Missile Components (unclassified), Society for Non-destructive Testing and Southwest Research Institute, Gunter Hotel, San Antonio, Tex.

Feb. 15-17—International Solid-State Circuits Conference, Institute of Radio Engineers, Sheraton Hotel, Philadelphia.

Mar. 5-9—Sixth Annual Gas Turbine Conference and Exhibit, American Society of Mechanical Engineers, Shoreham Hotel, Washington, D. C.

Mar. 9-10—Second Symposium on Engineering Aspects of Magnetohydrodynamics, University of Pennsylvania, Philadelphia.

Mar. 9-10—Flight Propulsion Meeting, In-

(Continued on page 6)

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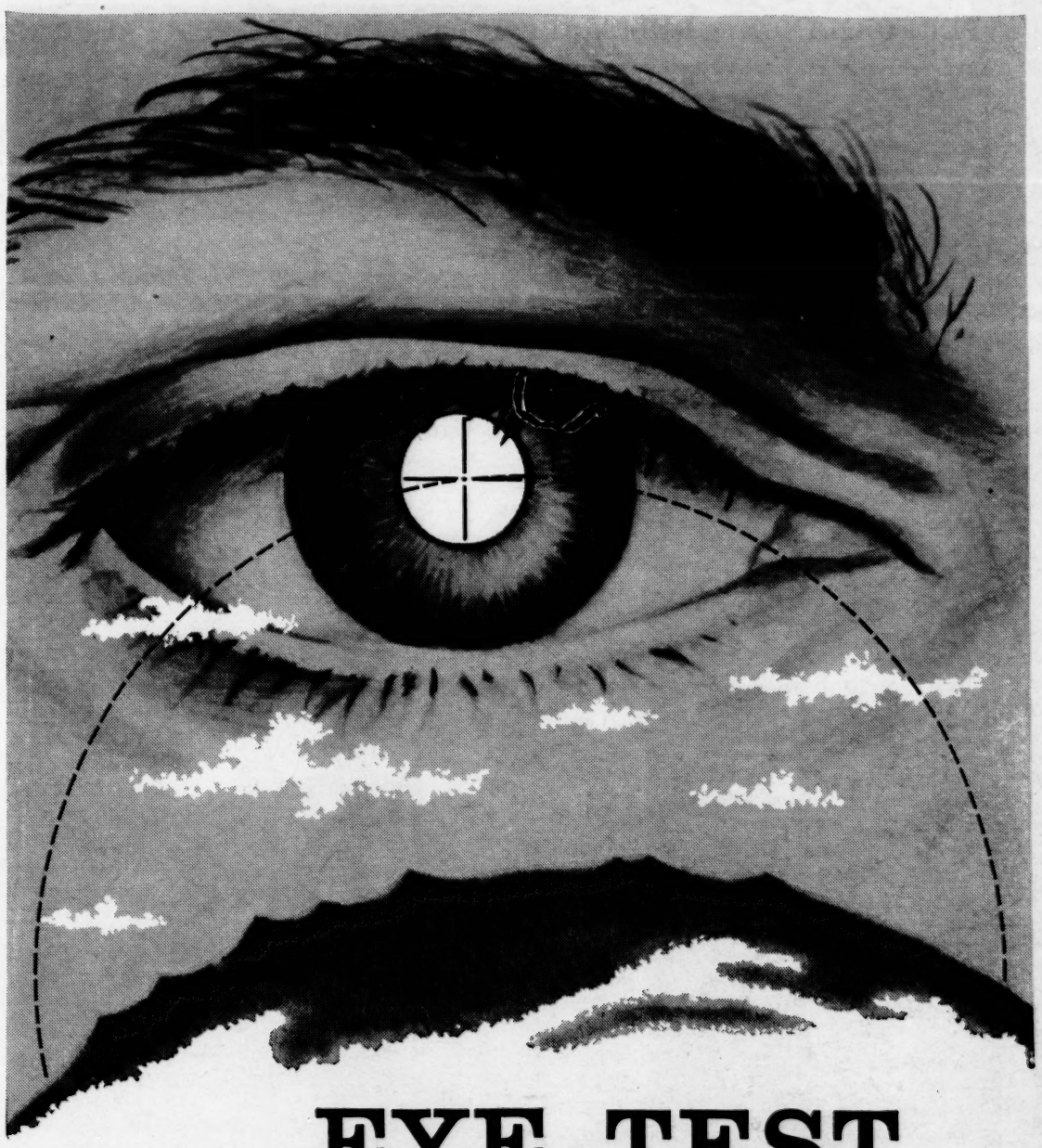

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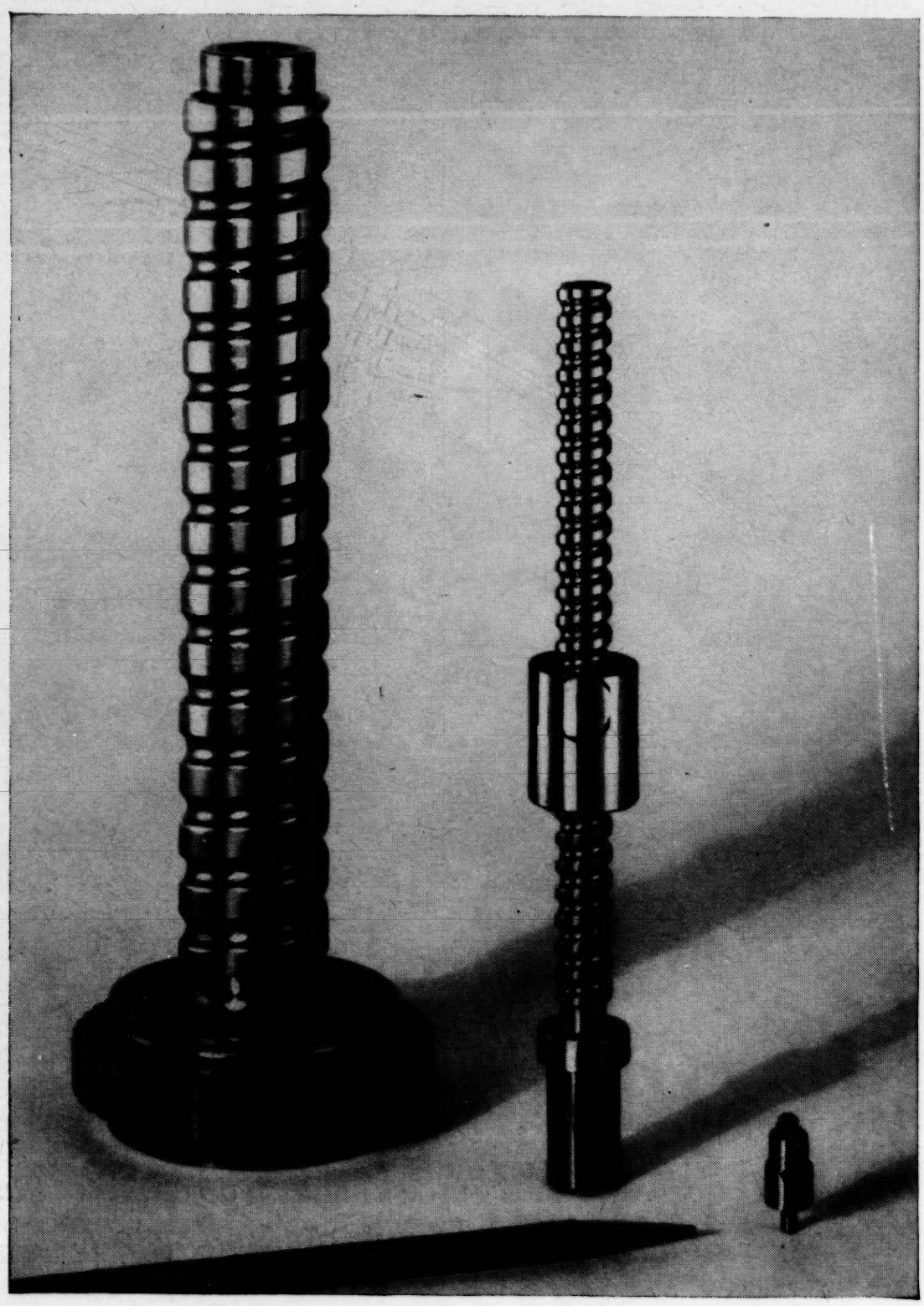

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(*Continued from page 5*)

stitute of the Aeronautical Sciences, Cleveland, Ohio (classified).

Mar. 12-16—Aviation Conference, American Society of Mechanical Engineers, Statler-Hilton, Los Angeles, Calif.

Mar. 13-16—Test, Operations and Support Conference, American Rocket Society, Biltmore Hotel, Los Angeles, Calif.

Mar. 16-18—Fifth National Conference on Aviation Education, Mayflower Hotel, Washington, D. C.

Mar. 20-23—International Convention, Institute of Radio Engineers, Coliseum and Waldorf Astoria Hotel, New York, N. Y.

Mar. 20-24—1961 Western Metal Exposition, American Society for Metals, Pan-Pacific Auditorium, Los Angeles, Calif.

Mar. 27-31—1961 Symposium on Temperature, Its Measurement and Control in Science and Industry, Columbus, Ohio. For information: V. W. Sikora, ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

Mar. 28-29—Nucleonics in Flight Symposium, American Nuclear Society, Statler-Hilton Hotel, Dallas, Tex.

Apr. 4-5—Aviation Technician School Administrators Conference, Purdue University, Lafayette, Ind.

Apr. 4-6—International Symposium on Electromagnetics and Fluid Dynamics of Gaseous Plasma, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

Apr. 4-6—Lifting Re-entry Vehicles: Structures, Materials & Design, American Rocket Society, Palm Springs, Calif.

Apr. 4-7—National Aeronautic Meeting, Society of Automotive Engineers, Commodore Hotel, New York, N. Y.

Apr. 10-11—Spring Meeting, Western States Section/The Combustion Institute, Aeronutronic Division of Ford Motor Co., Newport Beach, Calif.

Apr. 17-28—14th Technical Conference, International Air Transport Assn., Queen Elizabeth Hotel, Montreal, Canada.

Apr. 18-20—Symposium on Chemical Reactions in the Lower and Upper Atmosphere, Stanford Research Institute, Mark Hopkins Hotel, San Francisco, Calif.

Apr. 20-22—General Meeting, American Meteorological Society with the American Geophysical Union, Washington, D. C.

Apr. 26-28—Liquid Rockets, Propellants and Combustion Conference, American Rocket Society, Palm Beach Biltmore, Palm Beach, Fla.

Apr. 30-May 4—Seventh National Aero-Space Instrumentation Symposium, Instrument Society of America, Adolphus Hotel, Houston, Tex.

May 8-10—National Aeronautical Electronics Conference. IRE, Miami and Biltmore Hotels, Dayton, Ohio.

May 9-11—Western Joint Computer Conference and Exhibit, Ambassador Hotel, Los Angeles, Calif.

May 15-18—20th Annual National Conference, Society of Aeronautical Weight Engineers, Sheraton Hotel, Akron, Ohio.

May 22-24—National Telemetering Conference, Sheraton-Towers Hotel, Chicago, Ill.

May 26-June 4—24th French International Air Show, Le Bourget, Paris, France.

Sept. 4-10—1961 Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, England.

January 9, 1961

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EDITORIAL

Jottings From an Editor's Notebook

Culling notebooks filled with jottings during travels of recent months, we find many stray thoughts interlarded among major stories or editorials that have already been printed. Here are some that we think are still pertinent:

What has happened to the once vigorous technical leadership airlines exercised through Air Transport Assn. when Milton Arnold ran this technical show? It is badly needed in adding impetus toward solution of so many of civil aviation's growing safety problems. Also badly needed is some technically sound and politically honest input from the airline pilots, particularly from regular line pilots, in contrast to the chairborne union headquarters spokesmen who now do such an ineffectual job of presenting the pilots' case to both the federal regulatory agencies and the traveling public.

Current crisis in Laos again emphasizes the perpetual threat of the Communist technique of combining local political agitation with arms flow to ignite brush fire wars that so far have always ended with the red line of Soviet imperialism advanced another significant measure. What has really been done in the Pentagon to develop genuine capability for coping with this type of threat, ranging from simple support of internal security operations to large scale brush fire wars in underdeveloped areas of the world where neither adequate seaports nor airfields are available for the type of logistical support our allies want and need? Why don't we have either the rough field, bush country transports or the modern, non-nuclear-armed air support weapons for these operations? Who in the Pentagon is going to really tackle this problem of developing both the new tactics and equipment required?

Realizing TWA's Potential

Will the new trustee management provide the degree of executive stability required to bring Trans World Airlines back into its role of one of the world's potentially great airlines? And will the Civil Aeronautics Board continue its hard-nosed attitude toward the capricious maneuvers of Howard Hughes with an airline on which the traveling public and U.S. foreign policy depend? TWA has always had a great potential, and even brief periods of stable executive management under Ralph Damon, Carter Burgess and Charles Thomas proved the ability of its personnel to respond to the challenge of their job. CAB should continue to make it clear that stable management must be provided TWA in the public interest.

Will the new Defense Department executive team taking shape under the Kennedy Administration really tackle the repeal of Parkinson's law in the Pentagon, or will they follow examples of their predecessors and relax and enjoy it complete with Cadillac and chauffeur? Cleaning out the overlapping layers of "project engineers" in the upper civilian levels of the Pentagon doesn't require legislation or even executive orders—just determined action. Also, will the new Pentagon executives take up the decision-making reins that have been allowed to slide almost exclusively into the hands of the bookkeepers and comptrollers? A thorough shaking up is required to get military decisions back to the military, technical decisions made by the technicians and policy decisions by the top executives, with the bookkeepers relegated to keeping books.

When will the Civil Aeronautics Board wake up to the fact that the technical revolution they have been waiting for to produce "economic" helicopters is already here and will soon outspeed the Board's cumbersome procedures for coping with the expansion of the metropolitan helicopter transport network?

Air Force Needs Leadership

Will the Air Force develop some unified and effective leadership for its critical days ahead, or will it continue to operate basically as three or four intramural air forces and make key policy decisions on the advice of its retired West Point alumni association?

Will the Kennedy Administration spend as much effort getting better technical brains into the key spots of the government where they are urgently needed as it has spent recruiting political and economic brains?

Who will have the technical competence and energy and moral courage to carry on the job that E. R. "Pete" Quesada has started in the Federal Aviation Agency to restore precision and discipline to the airways and continue to develop, install and operate the equipment required for a modern air navigation and traffic control system? Will the pressure groups be successful in their inevitable assault on any new FAA administrator for a return to the lazy, do-nothing days of CAA, when the airways and safety situation degenerated into its present obsolescence?

Will the V/STOL effort ever get over the hurdle from experimental demonstration of principles to development into a militarily and commercially useful transport vehicle?

Will the airlines get over their fright over the prospects of a supersonic transport in the 1970s soon enough to cooperate intelligently with the development program to keep it within sound economic and operational boundaries? IATA's supersonic transport symposium in April at Montreal may provide part of this answer.

Will the airlines make any real effort to go after a larger share of the auto and bus market with low cost, minimum frill service that will really compete economically for a larger slice of the transport pie?

Will private corporations take advantage of President Eisenhower's policy statement staking out an area for commercial space communications systems and develop global television and message transmission systems via satellites as a good example of what American industry can accomplish in extending technical frontiers?

All of these questions are worth exploring further, and we intend to do so during the current year.

—Robert Hotz

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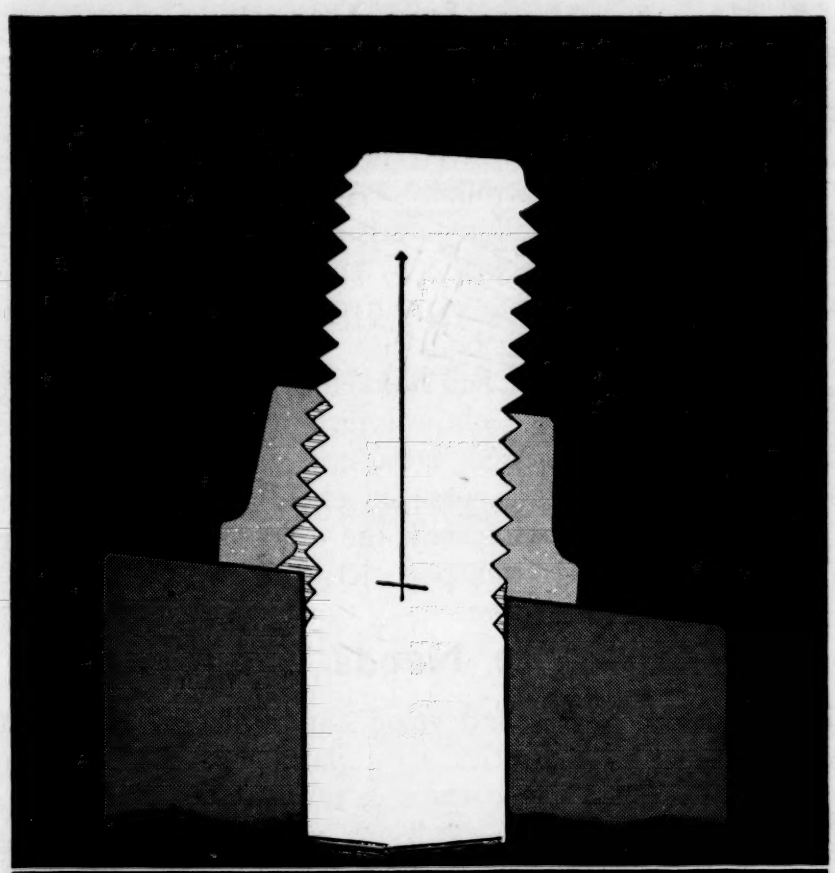
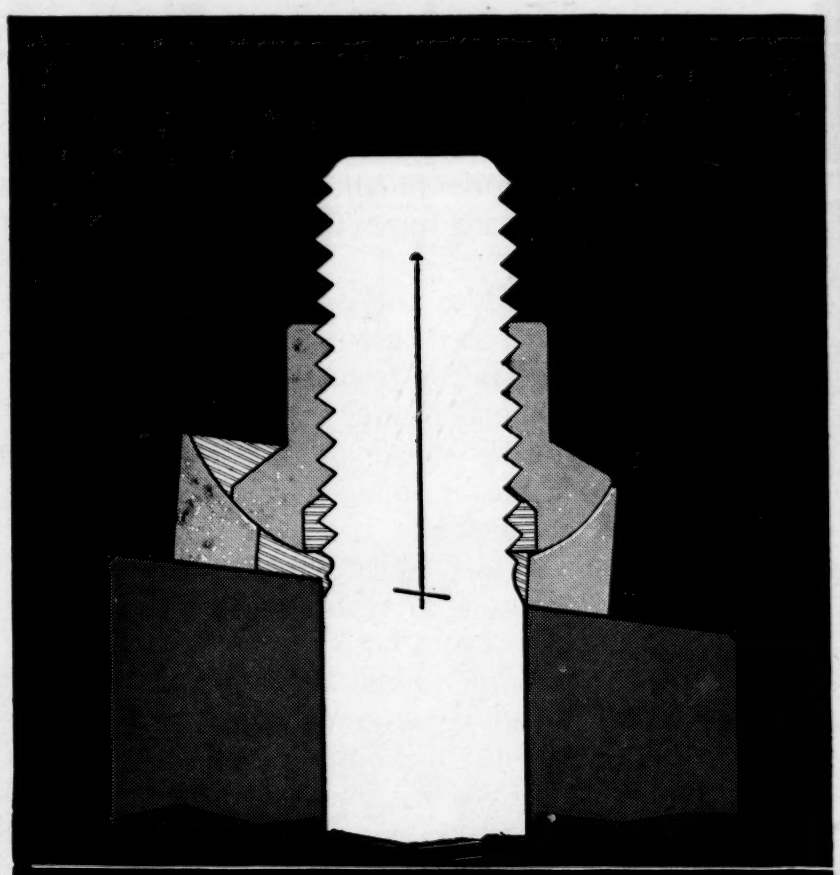
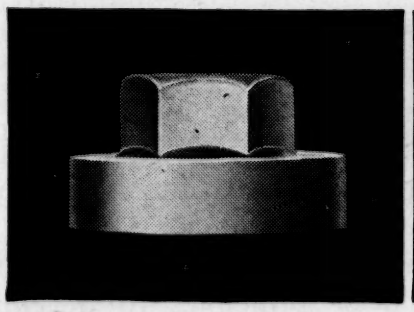


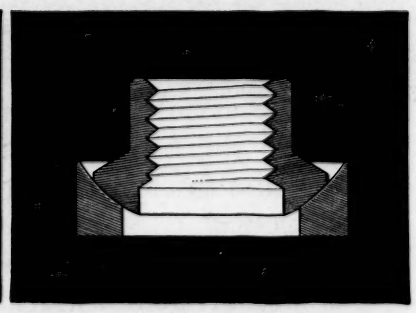
Bend in bolt is clearly apparent with an out-of-square condition of 8°.



Note how SPS Self Aligning Washer keeps nut perpendicular to bolt shank.

SPS Self Aligning Nut





The surface against which a nut seats cannot always be perpendicular to the threads of the mating bolt. An out-of-square condition of only 2° can shorten the life of a nut and bolt combination as much as 90%. Thus the need for a fast, simple, economical method for axial loading without bending . . . which is precisely where the SPS Self Aligning nut fits in.

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WHO'S WHERE

In the Front Office

Dr. Theodore P. Wright, president, Flight Safety Foundation, Inc., New York, N. Y. Dr. Wright is retiring as vice president-research at Cornell University.

Ostrom Enders has been appointed to the board's Executive Committee and Committee on Audit of United Aircraft Corp., East Hartford, Conn., succeeding **Harry G. Stoddard,** retiring. Mr. Enders is board chairman of The Hartford National Bank and Trust Co.

Albert J. Morris, president, Radiation at Stanford, Palo Alto, Calif., newly formed subsidiary of Radiation, Inc., Melbourne, Fla.

Solomon Hudes, vice president-engineering, Telechrome Manufacturing Corp., Amityville, N. Y.

Dale D. Myers, weapon systems manager, GAM-77 Hound Dog Program, North American Aviation, Inc., Downey, Calif. Mr. Myers is vice president of the company's Space and Information Systems Division.

W. E. Gregg, vice president-operations, Crucible Steel Company of America, Pittsburg, Pa., succeeding **J. D. Dickerson,** assigned new administrative responsibilities for the company. Also: **E. A. March,** director of technology.

George Ustin, vice president and general manager, Buchanan Electrical Products Corp., Hillside, N. J., a subsidiary of Elastic Stop Nut Corporation of America. Also: **James O. Johnson,** director-sales promotion and advertising; **Albert Mittleman,** manufacturing manager; **Charles F. Walker,** sales service manager.

Russell C. Spera, vice president-production, Schaevitz Engrg., Pennsauken, N. J.

George C. Liacouras, treasurer and chief financial officer, Simmonds Precision Products, Inc., Tarrytown, N. Y.

Melbourne A. Forrest, a director, Burns and Roe, Inc., New York, N. Y. Mr. Forrest is vice president of the company.

Kenneth A. Waldron, vice president-marketing, R F Products, a division of Amphenol-Borg Electronics Corp., Danbury, Conn.

James B. O'Maley, vice president-engineering, MacLeod Instrument Corp., Ft. Lauderdale, Fla.

Theodore S. Saad, a director, Solid State Materials Corp., East Natick, Mass. Mr. Saad is president of Sage Laboratories, Inc.

Bret H. Reed, a director, Missile Systems Corp., North Hollywood, Calif. Mr. Reed is the company's financial vice president.

William J. Mitchell, assistant vice president-market development, Mohawk Airlines.

Dr. Ernst A. Guillemin, vice president and director of research, Burnell & Co., Inc., Pelham Manor, N. Y. Dr. Guillemin is Webster Professor of electrical engineering at Massachusetts Institute of Technology.

Col. William T. Kemp, director of information, Air Materiel Command, Wright-Patterson AFB, Ohio, and **Col. Lee Baker,** deputy director. Also: **Lt Col. Milton Frank,** deputy director, Office of Information, Air University, Maxwell AFB, Ala.

(*Continued on page 121*)

INDUSTRY OBSERVER

► **Convair and Douglas are studying facilities and techniques required for a nuclear rocket flight test program. These company-funded studies parallel two $100,000 National Aeronautics and Space Administration studies awarded last August to Martin and Lockheed, which are to be completed in early spring.**

► Proposals for studies of unconventional rocket concepts (AW Dec. 12, p. 27) have been submitted to National Aeronautics and Space Administration by Beech Aircraft, Aerojet, Pratt & Whitney, General Electric Missile and Space Vehicle Department, Rocketdyne, Thiokol and General Motors Allison Division.

► **NASA is interested in Convair's proposed Atlas-G space booster, but lack of an Air Force requirement for such a vehicle as a weapon system means it probably will not be built. Missiles are shrinking instead of growing, and the Atlas-F with the Centaur second stage will be powerful enough to launch the Dyna-Soar IL. The G model would have uprated boosters and sustainer and could put 1,000 lb. in a 22,000-mi. orbit. Using the Centaur stage, it could put two tons in the same orbit.**

► Soviet Union has given Finland an Mi-1 helicopter and has promised to deliver larger, 10-12 passenger machines, probably Mi-4s, to Cambodia. Soviet helicopter pilots spent 10 days in Finland training Finnish pilots to operate the Mi-1, which will be used as an aerial ambulance.

► **Bell Aerosystems has submitted proposals in the Air Force competition for the reaction control systems on the Samos reconnaissance satellite and the Midas early warning satellite.**

► An estimated $40 million would be required in Fiscal 1962 to launch work on Project Aerospace Plane's airframe and liquid air cycle engine if the Air Force should move the project into development status. Currently, USAF plans to spend $20 million for feasibility studies next year (AW Dec. 26, p. 22).

► **Comprehensive briefing on the Corvus air-to-surface, radar-homing attack missile will be given top-echelon planners at Strategic Air Command headquarters soon by Ling Temco at SAC's request. Navy canceled the missile last year for budgetary reasons. SAC interest in Corvus probably stems from recent war-game studies which took into account the increased effectiveness of the Soviet Union radar network.**

► Pilot pool for the Project Apollo multi-man spacecraft may include specialists in such fields as astronomy and physics, plus at least one Project Mercury orbital pilot.

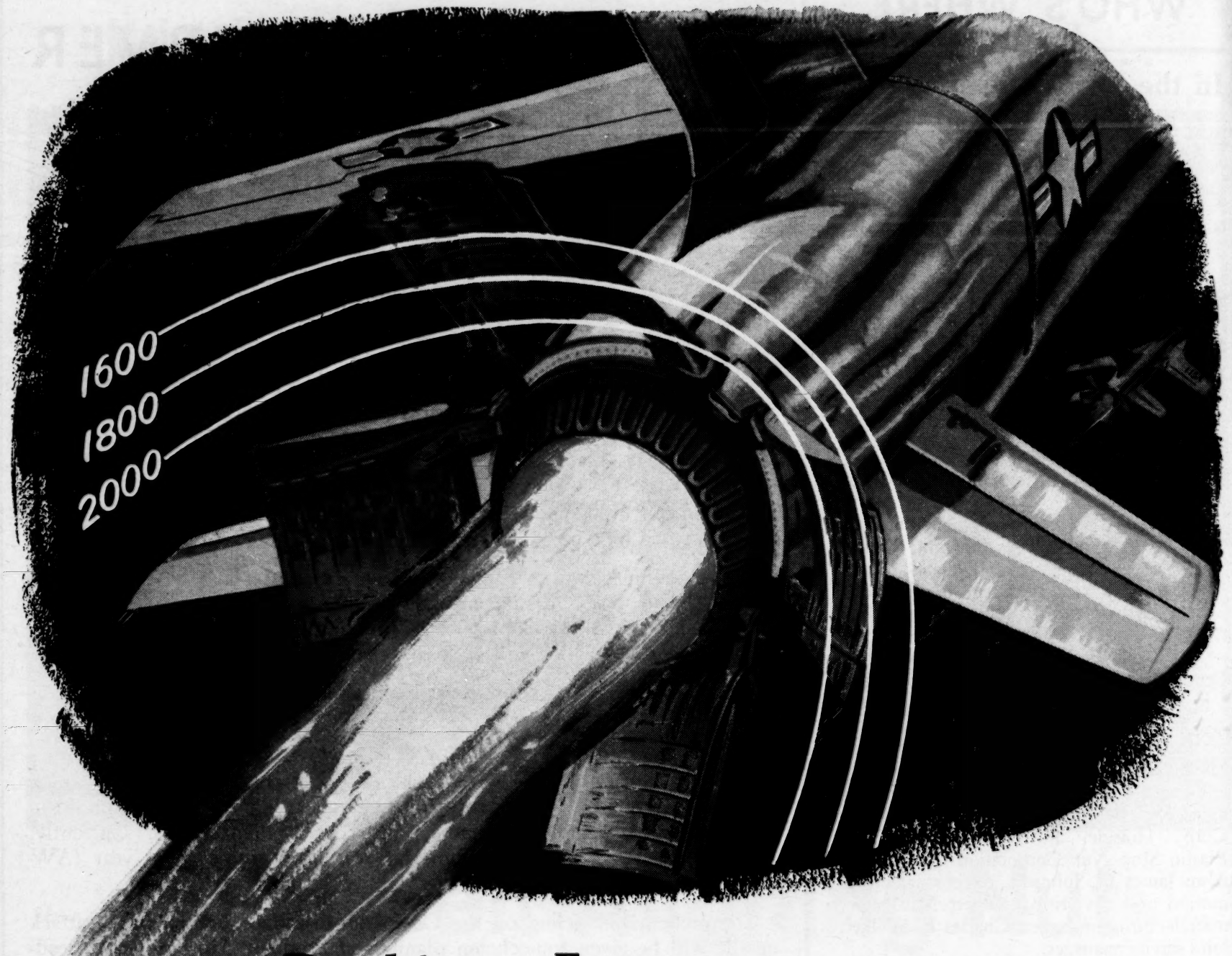
► **Navy Bureau of Weapons avionics facility in Indianapolis is evaluating industry proposals in the first step of a broad program aimed at developing avionic microcircuitry for future aviation and space systems. Contracts to be awarded this spring will cover development of techniques for batch and continuous deposition of thin films, deposition monitoring devices and materials research. Navy hopes eventually to have a complete model production facility to turn out microcircuits.**

► Soviet Union plans to build a telescope reflector with a main mirror six meters in diameter, which the Russians claim will be the world's largest astronomical instrument. Designed at the State Optical-Mechanical Factory in Leningrad, the telescope system will weigh 630 tons.

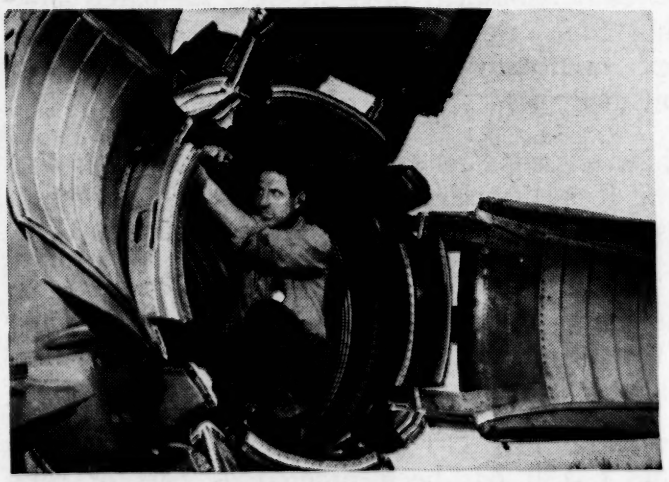
► **Rella, a multi-purpose air-launched probe, is being developed under sponsorship of Naval Air Missile Test Center, Pt. Mugu, Calif., to carry various sensing packages for measuring atmospheric phenomena.**

► Lockheed expects to deliver the first C-130E early next year. This extended range version of the C-130 has been ordered as part of the Military Air Transport Service modernization program.

► **Aeroflot is testing a British Decca navigational system on one of its turbojet Tu-104s. The Soviet airline plans to equip its aircraft on some international routes with special navigational instruments.**



Braking 23 Tons at 1200 MPH



Mechanic adjusts hinge of speed-brake door whose critical parts are of HAYNES alloy No. R-41.

Few brakes are called upon to take such a beating. That's why HAYNES alloy No. R-41 was selected for all critical areas of the petal-type speed-brake on the Air Force's new F-105 Thunderchief fighter-bomber.

Closed, the tail-mounted "petals" encircle the flaming gas blast behind the J75 engine's afterburner. Then, tremendous stress loads and thermal shock are imposed as the searing-hot doors whip open into the cold airstream—to check the blazing speed of the 23-ton, Mach 2 fighter.

HAYNES high-temperature alloys that resist temperatures of 1700 deg. F and over—for long periods and under great stress—today serve many hot spots. Resistance to stress, to thermal shock, to corrosion, erosion, and fatigue, are typical properties that make these alloys so extremely useful in turbojet engines, in ramjets, missiles, rockets, manned space capsules.

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Washington Roundup

Break With Cuba

Break in diplomatic relations between the U.S. and Cuba last week did not immediately affect operation of the large U. S. Navy base at Guantanamo Bay, missile and space flights over the Atlantic Missile Range, or flights of Pan American, National and Delta airlines into Havana.

Indications were that neither government would disturb existing relations in these areas pending the inauguration of John F. Kennedy as President late next week. The U. S. has maintained since Premier Fidel Castro took power that it would not get out of Guantanamo, for which it has a long-term agreement with Cuba. It also feels that all treaties and agreements affecting commercial air rights are still in effect. And Maj. Gen. Leighton I. Davis says he expects no changes in his operations at the Air Force Missile Test Center, even though Cuba still is agitating over the portion of a Transit satellite booster that dropped on Cuban soil (see p. 27).

Pan American operates 26 weekly flights from Miami, Delta four weekly flights from New Orleans, and National operates weekend services only from New York. None planned changes unless the situation grew worse.

Rep. Overton Brooks, chairman of the House space committee, will ask the Kennedy Administration to increase National Aeronautics and Space Administration's Fiscal 1962 budget to $1.5 billion.

Brooks said he has heard that NASA originally requested this amount but that the Eisenhower Administration reduced the request to $1.1 billion. Brooks considers a billion and a half dollars the minimum necessary for a program "that will place the U.S. in the forefront, where it belongs."

Space 'Reviews'

Brooks' committee now is billing its look into the space vehicle program as a "review," to distinguish it from an "investigation." It also will "review" the Mercury man-in-space program after the first manned ballistic flight is made.

Russia, meanwhile, sounds as if it is attempting to belittle ballistic manned flights. Academician M. M. Sisakyan says manned flights should not be made "only for the reason of advertisement." He said Russia long ago could have shot a man to heights of 60 to 250 mi., but "short flights to explore upper layers of the atmosphere will not bring any appreciable scientific results." Orbital flights are the real goal, Sisakyan said.

Outgoing Republican officials are not expected to testify before Congress on Eisenhower's Fiscal 1962 budget requests. Defence Secretary Thomas S. Gates has already said he prefers not to appear.

Rep. George Mahon's House appropriations subcommittee on the armed services hopes to begin hearings next Monday with background and policy briefing from Central Intelligence Director Allen Dulles and Gen. Lyman Lemnitzer, chairman of the Joint Chiefs of Staff.

Hearings will be complicated this year because the armed services committee must authorize all aircraft and missile procurement funds before the appropriations group can act.

Talent Search

Air Force Under Secretary Joseph Charyk, formerly an official of Ford Motor Co.'s Aeronutronic Division, is expected to keep his USAF job in the new administration and later succeed Dr. Herbert York as director of defense research and engineering. Lyle S. Garlock also is expected to stay on as USAF comptroller.

Top contenders for USAF's research and development assistant secretaryship are Marvin Stern, York's aide for strategic weapons, John Rubel, one of York's deputy directors, and Dr. Alexander Flax, Air Force chief scientist. Lt. Gen. Frederic Smith, commander of U. S. Air Forces Europe, now looks like the best bet as USAF Chief of Staff.

Najeeb A. Hallaby, Aerospace Corp.'s secretary-treasurer, is leading the list of candidates for Federal Aviation Agency administrator. Former USAF assistant secretary Harold Stuart, mentioned earlier for the Air Force secretaryship, also is in the running, as is James D. Ramsey, director of Michigan's Department of Aeronautics.

Civil Aeronautics Board Member Alan Boyd still looks like the best bet for the CAB chairmanship. Sen. Mike Monroney is backing his aviation subcommittee special counsel, Robert Murphy, for a CAB membership and Sen. Claire Engle is pushing his assistant, Thomas Bendorf, for the same spot, arguing that California hasn't had Board representation for some time.

—Washington Staff

Air Support Vital to the Defense of Laos

Soviet aircraft are reported aiding rebel troops; U. S. prepares attack, airlift forces for action.

By Larry Booda

Washington—Landlocked Laos, which was the potential scene of a limited international war last week as Soviet aircraft supported Communist-led rebels, presents military planners with problems that would have to be solved almost entirely by air supply and support.

As the Joint Chiefs of Staff prepared last week to cope with any military requirements that might develop in the Southeast Asian nation, or in Cuba, they were hampered by lack of guidance due to the partial political vacuum created by the imminent change in administrations. The Eisenhower Administration couldn't commit the U. S. to any major policy moves beyond the end of its term on Jan. 20, and President-elect John F. Kennedy was cautious about assuming any responsibility for official action before he is inaugurated.

Pacific area commander Adm. Harry D. Felt launched a series of shifts and alerts to prepare U. S. forces scattered from the Philippines to Japan to support the Laos government if necessary. Air Force and Navy attack aircraft and Air Force troop carrier transports were prepared to support any action.

Laos, a mountainous country with no direct access to the sea, was invaded by rebel troops equipped and trained in neighboring Communist North Viet Nam. They joined other rebel forces already fighting in Laos. The State Department reported that these troops have been supported by Soviet and North Viet Namese transports which have made at least 184 flights between Dec. 15 and the middle of last week.

Observing Soviet Airlift

Evidence of the airlift by Soviet-built aircraft was gathered through observations and photographs made by U. S. aircraft attached to U. S. diplomatic missions in Laos and South Viet Nam. The reconnaissance was requested by the Laotian government (AW Jan. 2, p. 23).

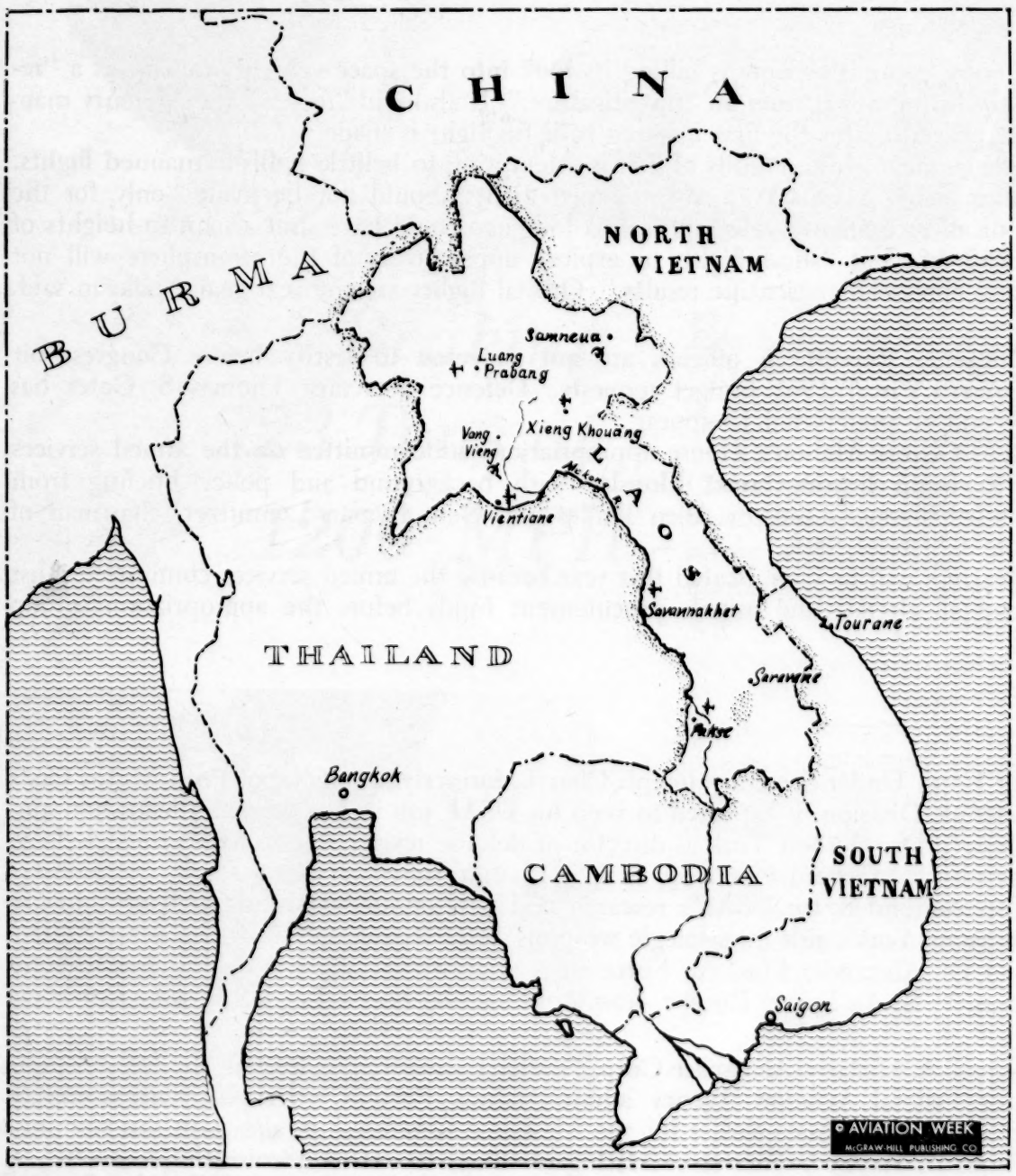
Air drops to the Pathet Lao rebel troops have been made with Soviet and Viet Namese Ilyushin Il-14s. They were observed at Vientiane airfield between Dec. 3 and 14, unloading 105 mm. howitzers, mortars, ammunition, gasoline and combat rations. Artillery men who set up and operated the field pieces wore brown uniforms not seen before in Laos and were well trained and well acquainted with their equipment.

Backing up the traffic into Laos, Soviet heavy aircraft have been flying over Communist China into the North Viet Nam cities of Hanoi and Haiphong.

Army alert troops available for immediate airlift to Laos were the 503rd Airborne Battle Group, part of the 25th Infantry Division, located on Okinawa. The First Special Force, a group specially trained in guerilla warfare, also is stationed on Okinawa. The 503rd has 1,900 men and the special force 1,200 men.

Navy has the attack carrier Lexington and the anti-submarine warfare carrier Bennington in Southeast Asian waters, along with 1,900 Marines carried principally in the attack transport Paul Revere and the landing ship (dock) Monticello. Augmentation of the Far East Seventh Fleet was begun last July, and the force now is similar to the Sixth Fleet in the Mediterranean. Two other attack carriers, the Hancock and the Coral Sea, are in northern Asiatic waters.

Air Force troop carrier and fighter bomber wings, which would transport and support troops, are located in the Philippines, Okinawa, Japan and Korea. Forces consist of three fighter-bomber wings flying F-100 aircraft, the 315th Troop Carrier Wing equipped with



VIENTIANE airfield is only one in Laos which can accommodate aircraft of C-130 and C-54 size. This airfield and those at Savannakhet and Pakse can accommodate planes of C-119 size. Airfields at Luang Prabang and Xieng Khouang are two of about 25 places in Laos at which DC-3 type aircraft can land. Hammer-and-sickle marks show general area where Russian supply drops have taken place (AW Jan. 2, p. 23).

C-130s, one light bomber wing flying B-57s, two air defense wings flying F-102s, and one tactical reconnaissance wing with RF-101s.

Only one airfield in Laos, located at the administrative capital of Vientiane on the Mekong River, can accommodate aircraft of C-130 and C-54 size. Three airfields can accommodate C-119 aircraft. They are Vientiane, Seno airfield at Savannakhet, and Pakse. Seno is a French military airfield.

There are about 25 places in Laos where C-47 or DC-3 aircraft can land. They cannot be called airfields because in many cases they are simply pastures.

Principal action by the Pathet Lao and government forces the last two weeks has been in the area between Vientiane and Luang Prabang, the royal capital to the north. Only along the Mekong River, which is the principal border between Thailand and Laos, is there a concentration of civilization. The relatively level area where the current fighting is in progress is called Pleines des Jarres.

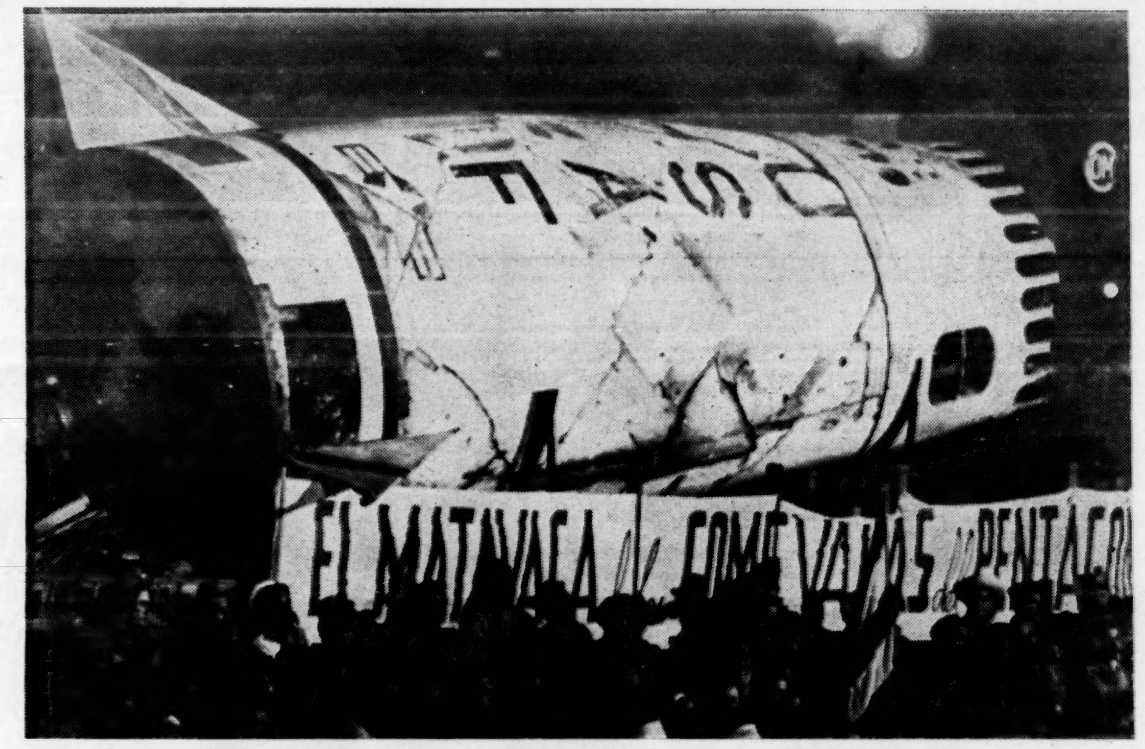
Land Transport

A narrow-gage, single-line railroad extends from Bangkok, Thailand, on the Gulf of Siam, northward toward Laos, splitting into two branches which terminate across the Mekong River from Vientiane and near the river at Pakse. Motorized ferries carry goods across the river. Land transport within Laos is very rudimentary.

The eastern border of Laos is a ridge of high mountains. It is through passes in these mountains that invasions from North Viet Nam have originated. In the region of Dien Bien Phu there has been heavy infiltration, and it is through the next pass south at Nong Het that the most recent invasion came. There is another pass to the south at Mua Gia, and one at the border of South Viet Nam, about 50 mi. west of the seaport of Tourane.

Between the eastern and western borders of the 500-mi.-long country is dense jungle which is flooded during the monsoon season, which lasts from May until September. No pitched battle type of warfare can be waged during this period. Any supply drops from the air would have to be in clearings and in cooperation with the volunteer troops of Laos. These volunteers fight only in their own region. Regular army troops of Laos are not limited in their areas of operation, but they need cooperation from local troops who know the terrain.

Close air support of troops would be futile in the opinion of military men who have been on the scene. Any attempt to bomb troops on a jungle trail would "kill more snakes than men," they say.



Thor Booster Displayed in Havana

Castro's cow-killer, remnants of the forward portion of a Douglas Thor booster which fell in Cuba Nov. 30, was reconstructed as the grand finale for a Havana military parade Jan. 2. Banner identifies the rocket as "The Cow-Killer and Eater from the Pentagon." Section shown is upper portion of booster for Transit III-A shot destroyed by range safety officer following booster failure a few minutes after lift-off. Tail fins have been incorrectly attached to this section presumably to make the exhibit more impressive. First Cuban reports following impact of the rocket said it fell in an uninhabited area, and about 40 lb. of fragments were recovered (AW Dec. 5, 1960, p. 25). But size of this reconstruction indicates considerably more fragments were found. In another development, the United States last week formally ended diplomatic ties with Cuba after the Cuban government demanded that the U. S. Embassy in Havana cut its staff to 11 persons (see p. 25).

B-52H Rolls Out With Skybolts

Wichita, Kan.—Flight tests to check compatibility of the Douglas GAM-87A Skybolt air-launched ballistic missile with its Boeing B-52 carrier are scheduled to begin here Jan. 12.

Rollout here of the new Boeing B-52H missile platform bomber and the Douglas Skybolt last Thursday provided the public with its first view of a weapon system designed to deploy four of the air-launched inertial-guided missiles per bomber 1,000 mi. from multiple targets, with the Stratofortress capable of penetration to strike additional thermonuclear blows, posing complex problems to enemy air defense planning.

Only portion of the system on which operational dates seem secure now is the B-52H platform bomber, which is slated to begin first flight in March and is scheduled for initial delivery to Strategic Air Command in May. Skybolt ALBM program has suffered a severe cutback in funds (AW Dec 19, p. 26). Earlier indications were that the new weapon system would be operational with SAC in 1964.

Although the Skybolt display here last week had four of the missiles hung under a B-52H, initial flight trials at least will be made with the missiles slung from a B-52G testbed configured to a B-52H to speed the development program release to squadrons. Flight testing of the B-52H and Skybolt system will be done on the Atlantic Missile Range before the weapon system becomes operational.

Six SAC strategic wings, of 16 airplanes each, are scheduled to receive the new P&W TF-33 turbofan B-52Hs, the first being the 379th Strategic Wing, now a B-47 outfit, which will be based at Wurtsmith AFB, Mich. Boeing-Wichita is scheduled to complete deliveries of B-52Hs to all six wings in 1962.

Dummy missiles carried under the B-52H at rollout duplicate the operational version in size, weight and center-of-gravity location. Each of the GAM-87As weighs approximately 11,000 lb. and measures about 39-ft. long. Maximum diameter is approximately three feet. Skybolt is designed for a first stage of approximately 37,000-lb. thrust and a second stage of some 19,000-lb. thrust. Solid fuel would be temperature-protected by an electric blanket system.

Missile's main body, plus nose, measures 33 ft.; the remainder of its 39-ft. over-all length comprises a conical tail fairing, which is jettisoned by explosive bolts. Nose section diameter is 20 in. Missile has eight triangular fins.

First Photo of Dassault Etendard Recon Fighter

First photo of Dassault Etendard IVP reconnaissance fighter shows the plane fitted with a three-camera unit in the nose, replacing the Dassault-developed Aida radar used on the IVM model. Note camera window in nose side panel, and flight refueling probe jutting from nose. Belly gun has been removed to permit a twin-camera installation.

Kennedy Names Defense Controller; Other National Security Jobs Filled

Washington—Charles J. Hitch was named Pentagon comptroller last week as President-elect John F. Kennedy continued to fill top level national security jobs in his new administration.

Hitch, chief of the Rand Corp. research council, will be assistant secretary of defense, comptroller. Other national security officials named:

- **McGeorge Bundy,** dean of the faculty of arts and sciences at Harvard University, as Kennedy's special assistant for national security.
- **John J. McCloy,** New York banker and attorney, as director of the United States Disarmament Administration.
- **Cyrus R. Vance,** New York attorney who has served as assistant counsel of the Senate Preparedness Investigating Subcommittee, as Defense Department general counsel.

Resignations Mount

As the new administration was being formed, resignations mounted among officials of the present administration, which leaves office Jan. 20. They included Elwood R. Quesada, Federal Aviation Agency administrator; Perkins McGuire, assistant secretary of defense, supply and logistics; Arthur E. Summerfield, postmaster general, and Frederick H. Mueller, secretary of commerce. Resignations also included Whitney Gillilland as chairman and Chan Gurney as vice chairman of the Civil Aeronautics Board, although both will continue to serve as CAB members.

Hitch, 50, was born in Booneville, Mo., and received his bachelor's degree in economics from the University of Arizona in 1931. He also attended Harvard and Oxford Universities. During World War II, Hitch served as staff economist for the mission for economic affairs in London, a lend-lease group headed by W. Averell Harriman, who also was picked by Kennedy for a post as roving ambassador for the new administration.

In 1942 and 1943, Hitch was on the planning committee of the War Production Board, and from 1943 to 1945 he served as an officer in the Office of Strategic Services.

Before joining Rand Corp. as chief of the economic division in 1948, Hitch was chief of the controls division of the Office of War Mobilization and reconversion. He currently resides in Pacific Palisades, Calif.

Vance, 43, was born in Clarksburg, W. Va., and has law offices in New York and Washington. In World War II, he served as lieutenant on destroyer duty. For the last three years, he has served as assistant counsel during joint Senate space and preparedness hearings. Both the space and preparedness committees were headed by Sen. Lyndon B. Johnson, the Vice President-elect.

Bundy, a Republican, will take over the post now held by a Democrat in the Eisenhower Administration, Gordon Gray. As special assistant for national security, Bundy will be required to serve as executive officer of the National Security Council and coordinate military, domestic and diplomatic policies.

Bundy was born in Boston Mar. 30, 1919, and he received his bachelor's degree from Yale in 1940. He served as political analyst on the Council of Foreign Relations from 1948 to 1949. From 1949 to 1951 he was lecturer at Harvard University, and from 1951 to 1954 he was associate professor of government. Bundy has been dean of the faculty arts and sciences since 1953.

Expanded Office

McCloy, also a Republican, will head the agency created by the Eisenhower Administration last August, which is an expanded version of an office run earlier by Harold E. Stassen.

As director of the new Disarmament Administration, McCloy will presumably work closely with Paul H. Nitze, assistant secretary of defense for international affairs, who has been given responsibility for the development of disarmament plans. He will report directly to the secretary of state and the President.

McCloy was born in Philadelphia Mar. 31, 1895, and he received degrees from Amherst College and Harvard University Law School. He served as an artillery captain in France during World War I and became an assistant secretary of war during World War II. From 1946 to 1947, McCloy was president of the World Bank, and from 1947 to 1949, he was high commissioner for Germany.

Air Force Management Concepts Attacked by House Subcommittee

Washington—Congress has issued another report critical of fundamental Air Force missile program management concepts, particularly attacking USAF reluctance to build in-house management resources.

The House Manpower Utilization Subcommittee report is the latest in a series which has criticized the Air Force management approach. It objects basically to what it calls expensive, cost-plus-fee contract arrangements, and this is particularly significant in view of the new USAF relationship with Aerospace Corp., which is now building a staff to assume technical direction of Air Force missile and space programs.

Defending Air Force management philosophy, Secretary Dudley C. Sharp maintained that USAF holds over-all direction and management of its projects through its staff of 400 technical officers in Air Research and Development Command.

Decision to contract with Aerospace, after a similar arrangement with Space Technology Laboratories came under heavy congressional fire, was made following careful consideration of the complete in-house approach, Sharp said.

The Air Force secretary pointed to the Atlas and Thor programs as proof of the desirability of the Air Force/industry management concept, and he said the concept eventually will result in development of a vast U. S. industrial base.

In a letter to Rep. James C. Davis (D.-Ga.), Manpower Utilization Subcommittee chairman, Sharp said he believes the finest talent should be concentrated on the challenges of the space age. "It does not follow, however, that all of such competence must be mobilized within agencies of the government—that these scientists and engineers must uniformly become employes of the United States."

Rep. Davis, in his letter of submittal, said the continuing inquiry into Air Force management was undertaken because of the effect on manpower utilization "of the growing practice of some departments and agencies to contract out their administrative responsibilities and, secondly, because of the apparent duplication and ineffective use of manpower in such important areas as the missile program."

Complaints against the Air Force center around five factors outlined by the Davis subcommittee and the General Accounting Office:

- **Reluctance of the Air Force** to establish its own resources to manage completely the ballistic missile program.
- **Reliance by Air Force** on a cost-plus-fee contractor in the management role.
- **High costs** of the contract arrangement for program direction.
- **Exceptional individual** profits arising from contractual arrangements.
- **Failure of the government** to take title to valuable patents.

Responding to specific questions about Aerospace Corp. asked by Davis, Sharp provided this data:

- **Financial arrangement** will be on cost reimbursement basis, with a fee now under negotiation. Fee to STL was estimated by USAF at under 10%. Salaries will be reviewed by the Air Force, which has made an advance $5 million payment to finance initial operations.
- **Staff** is to total 2,500 by July and 3,500 a year later. A number will be former STL and government employes.
- **Patent rights** are under negotiation with Aerospace.
- **Facilities** will be furnished to Aerospace under same terms as they are furnished to other defense contractors.

The Davis report was made to the House Post Office and Civil Service Committee and follows a 1959 position report on Navy and Air Force missile management concepts. Initial study was followed by two General Accounting Office reviews (AW May 30, p. 30) in which the financial makeup of STL and its predecessor, Ramo-Wooldridge Corp. were examined.

The current report brings up to date exchanges since the Air Force announcement in June "that it had chosen to continue the use of contractors for directing the various missile and space programs. In so doing," the report said, "the Air Force, by this latest action, has selected a totally new group, the Aerospace Corp., without personnel and without equipment, in place of expanding its own within-house resources."

Aerospace Corp. is taking over the broad administrative and research functions of STL, which will continue as systems engineering and technical director for Atlas, Titan and Minuteman weapons systems (AW June 13, p. 34).

U. S. Army's Davy Crockett Weapon System

Davy Crockett, Army's Jeep-mounted nuclear weapon system, is shown with its titanium launcher erected in a simulation of actual field conditions. The system is made in 200 and 400 lb. versions and is capable of delivering missiles of up to 20 kiloton yields at close ranges (AW Aug. 15, p. 30). Designed to be operated by two men if necessary, the weapon can fire missiles with conventional high explosive warheads as well as nuclear projectiles.

FAA Pushing Control System Development

By Philip J. Klass

Washington—First of the Federal Aviation Agency's new semi-automatic data processing and display systems, expected to provide a significant advance in air traffic control, is scheduled to become operational in the Boston area within two years.

FAA's Bureau of Research and Development (BRD) has launched an all-out effort to place the newly developed equipment into operational use, moving at a pace characteristic of a crash military program.

The bureau will retain program control until after the first system is installed and operating, an innovation for the FAA which follows the pattern of the Air Research and Development Command in its responsibility for newly developed weapon systems.

Present schedule calls for the new semi-automatic traffic control system to be installed and operational in the New York area by early 1964. Initially, Boston will have only an en route traffic computer capable of conflict prediction only for en route flights. A terminal area traffic computer will be added during the subsequent year. However, automatic print-out of flight progress strips will be available in Boston from the start. At New York, FAA hopes to install the complete system initially, if manufacturers can meet its timetable.

Two-Source Competitions

Recognizing the value of competition in spurring contractor efforts, the bureau is holding two-source design competitions for major items in the Boston-New York system installations.

Although Fiscal 1962 budget figures have not yet been released, FAA is expected to seek about 20% more than the $64 million authorized in Fiscal 1961 for the bureau's activities. About 80% of the requested funds will be used for research and development, with the balance going for new facilities and salaries.

Companies seeking contracts will find the bureau a hard and exacting negotiator. This is partially a result of heavy dollar and time overruns on the semi-automatic data processing and display system development program, the first major development of which was launched by the bureau's predecessor organization, the Airways Modernization Board.

Wherever possible, the bureau now insists upon using fixed-price contracts. Where program uncertainties prevent, it will use cost-plus-fixed-fee contracts, but usually with a liability limitation clause which fixes the maximum cost it will pay.

In several existing CPFF contracts, the bureau has included penalty clauses which reduce the contractor's fee if he is late in delivery or completion. But this is not a one-way street. In Librascope's contract for computers to be installed at Boston, the company will get 20% of any saving in costs below contract figures, with FAA getting the remaining 80% of the saving. The contract figures were reached after hard bargaining and are based on experience in building the first experimental units now on test at Atlantic City.

Assuming Management

The bureau also is taking over more and more of the systems management functions for its program, contracting this out only when it believes it lacks the technical competence.

For example, the bureau is taking over the systems management role formerly held by General Precision Laboratory in the semi-automatic traffic control system and buying major elements of the system directly from the equipment manufacturer rather than through GPL as it did for the experimental system. The bureau also has taken over management of the joint Air Force-FAA-Weather Bureau program to develop an automatic system for weather observation and forecasting (433-L), formerly managed by Air Force and prime contractor United Aircraft.

FAA was critical of program management and felt that a less expensive program could be used to determine concept feasibility than was previously planned. The basic concept calls for automatic weather observation stations, feeding data into a central computer on a real-time basis, which would be used to compute weather forecasts.

Instead of setting up a large network of new weather observation stations, FAA plans to use four existing weather stations at New York (Idlewild); Atlantic City, N. J.; McGuire AFB, N. J., and Washington, D. C. A network of eight miniature stations also will be built around Atlantic City, each supplying observation data to a central computer, to determine if such a system can accurately predict weather conditions over an airport from measurements made in the surrounding vicinity. This system is called a Micro-Meso Network.

FAA plans to use digital computers, already installed or planned for Atlantic City, for weather system forecasting instead of buying computers solely for weather use.

The fact that FAA's Bureau of Research and Development was willing to challenge Air Force management of the weather system program, and won its case, testifies to the fact that it is increasingly confident of both its abilities and its authority. This move also refutes early criticism that the bureau was being staffed so heavily with military personnel that the result might be subservience to military airspace users. James L. Anast, the bureau's director and a former USAF officer, spearheaded the recent action on the weather system reorientation.

The bureau's rapid acquisition of personnel in the past several years will taper off sharply. Under present plans, the organization will grow less than 5% over its present 1,600 manpower figure despite the fact that it has assumed the systems management role for the semi-automatic data processing system.

Collision Avoidance

The recent midair collision in New York pointed up the value of and the need for information on the altitude of aircraft operating in a terminal area. The bureau currently has two programs under way, either of which could provide such information:

- **Height radar,** new experimental AHSR-1, now being completed at the Atlantic City facility, will begin flight test evaluation within two months. The equipment, developed by the W. L. Maxson Corp., is a passive type of radar that operates from echoes produced by radar energy transmitted from the main airport surveillance radar.
- **Radar beacon altitude reporting,** which would enable airborne traffic control transponders to report automatically an aircraft's barometric altitude, has been under investigation and the bureau shortly will initiate procurement for an experimental altitude encoder to be used in flight tests.

Other important programs which the bureau will be pushing during the coming year include:

- **Air collision avoidance system,** developed by Bendix Radio, will start flight evaluation at Atlantic City shortly. BRD also expects soon to test a system developed by Motorola, and a new type of airborne antenna which would form the heart of a proximity warning/collision avoidance system proposed by Sperry. (For additional details on the bureau's air collision/proximity warning system program, see AVIATION WEEK, Dec. 26, p. 26.)
- **Blind landing system techniques** will be evaluated, including the Bell Aerosystems AN/GSN-5 and Gilfillan Regal groundbased systems. BRD also is installing at Atlantic City the British-

developed/BLEU (Blind Landing Experimental Unit), which uses an airborne radar altimeter and computer for pitch axis flare-out and a ground-installed magnetic leader cable for azimuth guidance. The system will be flight tested, starting this spring, alongside an improved ILS system in a joint U.S.-British evaluation program.

Another important program is the evaluation of sea-going Vortac navigation aids, now installed on the Coast Guard cutter Androscoggin, which could prove the basis for Vortac airways over the North Atlantic.

A companion program calls for the installation of two VHF scatter communications stations covering the western approaches of the North Atlantic routes, to evaluate the usefulness of this technique for extending VHF ground-air communications coverage over the North Atlantic and easing congestion in the HF band, which also is subject to atmospheric outages. Preliminary tests conducted by Pan American from Ireland indicate that use of tropospheric scatter techniques can more than double usual line of sight range of VHF (AW Jan. 18, 1960, p. 46).

Power Study Proposals Due for Project Csar

Dayton—Proposals are due today for a Wright Air Development Division study contract for a 4-kilowatt solar-voltaic source to power a 24-hr. communication satellite in USAF's Project Csar (Communication Satellite, Advanced Research).

Csar involves research aimed at producing information that could be applied to a communication satellite that would be operational in four years and initially would have a one-year lifetime, with a later goal of three to five years' life. It would contain a large number of repeaters and a great number of channels, including television and highly secure single channels.

Solar array must have a conversion efficiency, demonstrable in the contractor's plant, of 15%. It might produce no more than 8% in the space environment. Present capability demonstrable on the ground is about 12% in quantity production, indicating that the 15% requirement will involve careful cell selection. Weight requirement is a quarter pound per square foot.

The 4-kw. raw power requirement also is a very high target, since top rating in systems today is about 35 to 40 watts. National Aeronautics and Space Administration's Jet Propulsion Laboratory plans 180 watts of raw power from two panels in the Ranger I and II projects. The 4-kw. requirement with a 70 to 75% conversion efficiency produces a net power of about 3 kw.

New York Collision Hearings Point to New CAB, FAA Friction

New York—Friction between Federal Aviation Agency and Civil Aeronautics Board mounted last week as CAB investigators, testifying during the opening rounds of a public hearing, disclosed precisely where and when on Dec. 16 the midair collision occurred here.

Piecing together information from eyewitnesses, transcripts of pilot-controller conversations and flight recorders carried by the stricken aircraft, a 21-man CAB accident investigation team concluded the crash took place one-half mile northwest of Miller Army Air Field on Staten Island at 10:33 and 33-42 sec. EST.

The collision, which claimed 136 lives, involved United Flight 826, a DC-8 out of Chicago, and TWA Flight 266, a 1049A Constellation bound for La Guardia Airport. En route to Idlewild Airport, the United jet apparently overshot the Preston Intersection, its clearance limit, after initiating a rapid descent from 14,000 ft. about 21 naut. mi. from the holding fix (AW Dec. 26, p. 27).

According to FAA transcripts, the DC-8 pilot, asked whether he could descend to 5,000 ft. prior to Preston, replied: "Er, will head it right on down, we'll dump it." But according to David Thompson, chairman of CAB's flight operations group probing the incident, the words, "we'll dump it," were never spoken.

Investigators, Thompson maintained, felt that this portion of the transcript was hopelessly garbled and forwarded it to Bell Telephone Co. laboratories for speech analysis. The telephone company report will be made a part of the official record when forthcoming, he said.

The "we'll dump it" remark was widely interpreted to mean the DC-8's pilot was nosing his aircraft over to gain a maximum rate of descent. Had he done so, the jet's airspeed would have increased rapidly unless thrust reverser buckets were closed and acting as dive brakes.

Rift between FAA and CAB spokesmen at the hearing widened further after FAA counsel questioned the time sequence furnished by CAB to establish the Constellation's time and altitude in the minutes preceding the collision. Referring to an 8 sec. difference between two versions of the La Guardia Approach Control transcript, FAA's attorney at the hearing asked:

"Are you [Joseph Zamuda, chairman of the CAB flight operations group investigating the Constellation's role in the crash] prepared to state which is the correct time sequence now?" Zamuda replied that he was not.

Another significant detail emerged from the hearing as a result of Zamuda's report that, "correlation of the flight check [conducted by FAA on the day following the collision] indicated that the Preston fix, as well as the Linden fix, were . . . correctly plotted or marked on the appropriate radar scopes."

Apparently taking issue, Capt. J. D. Smith, central air safety chairman of the Air Line Pilots Assn., asked Zamuda if he were aware that Preston also served as a holding fix for La Guardia Approach Control and that the intersection was still unmarked on the radar scopes used by the airport's approach controllers? Zamuda replied that he was aware of this situation, although it had not been mentioned in his report.

Later in the hearing, it was brought out that American Airlines Flight 100, being worked by La Guardia Approach Control, was in the Preston stack at the time of collision.

In all, CAB investigating teams have interviewed 125 alleged witnesses, who either observed the collision or saw the aircraft as they plunged into Staten Island and Brooklyn. More than the 39 witness statements introduced into evidence last week are expected as the investigation unfolds.

Consensus of those witnesses at the hearing, however, was that:

- **Neither the United DC-8** nor the TWA Constellation engaged in any violent evasive maneuvers.
- **Jet seemed to "descend** out of the haze" above the Constellation, but both aircraft were clear of actual clouds at the time of collision.
- **No breaks in the overcast** were apparent to observers near Miller Army Air Field; most agreed that it was snowing or drizzling or both when the crash occurred.
- **Constellation's right wing** separated from its fuselage and empennage section, which fell to earth in a flat spiral.

To establish ceiling and visibility on the morning of Dec. 16, CAB has forwarded detailed questionnaires to 60 flight crews known to be in the area within one hour of the impact time. Preliminary returns from about 20 pilots have indicated that aircraft flying between 1,500 ft. and 10,000 ft. were inside clouds "on solid instruments" during this time span.

Altitude of the aircraft, as reported by witnesses, ranged from 700 ft. to 3,700 ft., with three measured sighting angles merging at the 1,500-ft. level.

Apollo Will Avoid Solar Radiation Hazards

By Edward H. Kolcum

Washington—Radiation shielding for the Apollo manned spacecraft can be built with existing design knowledge because newly developed theories indicate that solar storms can be predicted and avoided in the high orbital and cislunar flights planned for the vehicle.

An intensive government, industry and university attack on the problem of space radiation is beginning to pay off, particularly in the promise for accurate solar storm prediction. Valuable new data on radiation hazards has come from analysis of the biological effects of corpuscular radiation from the NERV payload (AW Sept. 26, p. 26).

Inadequate knowledge of the biological effects of protons from solar flares is considered the most serious deficiency blocking extended manned flight, but rather than attempt to shield against them, Apollo missions will be planned around the expedient of selecting flight times when the probability of solar storms is low.

Prediction theories developed by University of California Prof. K. A. Anderson have been so accurate that the National Aeronautics and Space Administration says all recent major solar proton activity could have been avoided either by not flying the mission, or by recalling the spacecraft if a flare was forecast after launch.

Anderson Theory

Anderson's theory is based on size of the sunspot penumbra, or outer half shadow, associated with 30 solar storms which occurred between May, 1957, and last June. By observing the penumbra at any given time, Anderson has found that it is possible to predict periods of high and low probability of major flare activity.

Dr. A. Gib DeBusk of Florida State University told AVIATION WEEK that analysis of the bread mold carried in the September NERV payload indicates greater cell damage and more mutations than the radiation level in the lower Van Allen belt was expected to produce. NERV package was in the belt 26 min.

DeBusk emphasized that the data cannot be extrapolated for a measure of possible damage to human tissue, and he said it would be necessary to conduct more NERV-type experiments to determine human effects.

Life scientists see the optimum manned spacecraft as a simulated earth environment, designed to provide a 14.7 psi. atmosphere, a self-contained magnetic field, and a storm cellar to protect the crew during periods of lethal radiation activity. The Apollo design need not be based on these sophisticated engineering requirements because they are not considered essential and because of the complication of the solar cycle.

Solar Cycle

The sun has a cycle in which the volume of solar activity peaks every 11 years. Last solar maximum was in 1958, a solar minimum will occur next in 1963, and the number of flares will then increase until the next solar maximum in 1969.

Prototype and test flights for the second-generation Apollo are planned for the period of the solar minimum, but third-generation manned spacecraft are likely to be lunar landing vehicles which will be under development at the solar maximum.

Competitive Apollo design studies are under way by Convair, General Electric and Martin, and it is possible that a storm cellar variation may be incorporated in the spacecraft by wrapping systems around the crew compartment for added shielding during the fast trip through the Van Allen radiation belts.

If the multi-man Apollo craft is programed to approach escape velocity in its cislunar flights, it could transverse the thickest portions of the two Van Allen belts in less than 30 min. It is more likely that the Apollo trajectory will minimize exposure in the radiation belts by flying through the horns. These are the thin northern and southern fringes of the geomagnetically-trapped corpuscular radiation belts.

The storm cellar concept (AW Aug. 1, p. 54) basically incorporates a heavily shielded compartment where crewmen would go in an emergency. Dr. Dale Smith of NASA's life sciences office says this concept, and a self-contained magnetic field, appear extremely attractive in designing the ultimate manned spacecraft to produce an environment similar to that on the earth's surface.

Space Stress Factors

He said radiation is but one factor in the over-all stress picture, and a thorough study of the biological effects of extended space flight must necessarily include the full spectrum of stresses. Among these are weightlessness, the work-eat-rest-sleep cycle, and periods of potential boredom.

Smith said a recent new look at the magnetic shielding concept indicates that this method should be tested. The idea was disparaged initially because it was believed that an unacceptably large power source—compared with the Boulder Dam installation—would be required to energize a field around a spacecraft.

Developments in solar power generation and nuclear auxiliary power (SNAP) have advanced to the point where the magnetic shield shows promise, he said. Theory is that by wrapping a d.c. coil around the spacecraft and creating a field with a force level of 0.4 gauss, the structure would act as a miniature earth by deflecting lethal energetic particles in the same way the magnetic field shields the earth.

Basic unknown in this concept is the deflecting radius—the extent to which the magnetic field should extend from the spacecraft. The trapped radiation would be bled off by degaussing the structure when it has passed through a danger area.

Innovations in storm cellar design could save payload weight for extremely long-term missions by radical design of the nuclear generator so that the reactor itself would be hollowed and internally shielded to form the storm cellar. In effect, the reactor, which must contain protective shielding for the crew, would also serve an emergency purpose by shielding the crew from cosmic radiation with its bulk and the external shielding which protects the crew from reactor radiation in normal operations.

Scientific Shortcomings

Within the area of basic radiation knowledge, Smith said, life scientists now lack:

- **Instruments to measure** the biological damage in non-recoverable scientific packages, such as deep space probes and long-term satellites.
- **Knowledge of the biological** effects of heavy cosmic primaries. Recently established index to describe radiation characteristics, called relative biological effectiveness (RBE), has not been established for heavy nuclei.

Like DeBusk, Smith feels a number of NERV-type and sounding rocket payloads should carry biological specimens on flights into the radiation belts.

Dr. John E. Naugle, energetic particles projects chief at NASA, told AVIATION WEEK that the second phase in a three-part program is under way to measure and analyze the Van Allen belts and cosmic radiation. The program was stalled last month when the Atlas Able lunar orbiter failed, preventing measurement of low-energy particle spectra and total radiation flux.

Next launch in the program, scheduled before June, is the Delta-boosted S-3 satellite, designed to measure energy

flux from 150 mi. to 40,000 mi. (AW July 4, p. 33).

Third program phase will be the eccentric and polar orbiting geophysical satellites, EGO and POGO, scheduled for launch in 1963-64, which will contain sophisticated instruments to measure flux, the energy spectrum and angular distributions.

Naugle said NASA's long-range program probably will include simultaneous measurements during the next solar maximum, with instruments analyzing solar storms as close to the sun as possible and as far away as possible.

First-generation payloads in the measurement of radiation have been severely limited in weight, telemetry and mission trajectory. Pioneer III, which provided data which led to discovery of the outer Van Allen radiation belt, contained only 13 lb. of instruments of which 3 lb. was assigned to radiation apparatus.

The S-3 Delta payload will weigh 82 lb., and EGO and POGO, to be launched by Thor-Agena vehicles, will weigh 1,000 lb.

Discovery and study of ionizing radiation in space is new enough to have caused conflicting and sometimes contradictory theories (AW Jan. 2, p. 40), but there is general agreement that additional experiments are necessary to assess precisely the effects of heavy dosages and the less understood biological effects of low dose levels, which could have insidious long-term results.

Pilot Training Planned For Redstone Launch

Washington—Detailed mission training for Mercury-Redstone pilots is expected to start soon at Cape Canaveral, Fla., in preparation for the first manned ballistic flight early next spring (AW Dec. 26, p. 16).

The seven Project Mercury pilots probably will be divided into two teams, one of which will go through the prelaunch training at Cape Canaveral and will furnish the pilot for the initial manned Redstone flight. The other team may go through training for later Redstone flights. These ballistic flights will be required to qualify a Mercury pilot to make an orbital flight.

Pool for the initial manned Redstone flight is expected to be composed of three pilots who will go to the Atlantic Missile Range from their permanent station at Langely Field, Va.

First manned ballistic flight will be programed on the same profile as MR-1, with a 16-min. period from launch to landing, including 5.5 min. of weightlessness, liftoff force of 6g, and re-entry force of 11g. The MR-1 capsule had an apogee of 135 mi. and a range of 235 mi.

President Affirms NASA Support Of Industry Satellite Operations

Washington—President Eisenhower has reaffirmed statements by National Aeronautics and Space Administration Administrator Keith Glennan that the advent of communications satellites will not alter the government's traditional policy of conducting international communications through licensed commercial companies.

Although operation of future communications satellite systems will be left to private industry, NASA will—as Glennan said—conduct the necessary research and development to advance satellite communications technology (see box).

This statement of policy at the top level of government has long been sought by the common carriers. Although President Eisenhower's statement will not be binding on the Kennedy Administration, the fact that the policy has been enunciated makes it less likely that it would be reversed without considerable public discussion.

Last Oct. 12, Glennan sought to reassure the common carriers that the government had no plans to enter the commercial communications field via satellites (AW Oct. 17, p. 26). The statement was favorably received, but there still was some question whether Glennan had the authority to speak for the Administration, since the President had not clearly assigned responsibility for communications satellites among the several interested executive agencies, including NASA, the Federal Communications Commission, Defense Department, State Department and the Office of Civil and Defense Mobilization.

In a subsequent letter, Sen. Lyndon Johnson asked Glennan whether his proposal to make government vehicles and launching and tracking facilities available to industry on a cost-reimbursement basis represented "approved policy." He replied that it does but will have specific approval before funds are requested (AW Dec. 12, p. 32).

President Eisenhower said he has directed NASA "to take the lead within the executive branch both to advance the needed research and development and to encourage private industry to apply its resources toward the earliest practicable utilization of space technology for commercial civil communications requirements."

The President called the early establishment of a communications satellite system "a national objective which will require the concerted capabilities and funds of both government and private enterprise and the cooperative participation of communications organizations in foreign countries. Increased facilities for overseas telephone, telegraph and other forms of long-distance person-to-person communications, as well as new facilities for transoceanic television broadcasts, through the use of man-made satellites, will constitute a very real benefit to all the peoples of the world," the President said.

NASA's current competition for development of an experimental communications satellite does not affect its offer to launch privately financed satellites, although the agency might suggest waiting until its own active repeater experiments have provided more information on which to base private designs.

So far, NASA has not received any formal requests from companies to launch such satellites, although a number of firms have begun holding technical discussions with the agency. Because of the high cost of launching and of operating the necessary ground station networks, few formal proposals are expected.

Communications Satellite

Washington—Proposals for an experimental satellite to develop technology for a civilian communications system will be requested after an industry briefing which will be held soon at Goddard Space Flight Center.

National Aeronautics and Space Administration will invite 21 companies to the briefing, where the agency will discuss requirements for a light, active-repeater satellite which will be used to explore technical problems facing operation of a commercial communications satellite system.

Companies invited to the briefing were American Telephone and Telegraph Co., General Electric Missile and Space Vehicle Department, Lockheed Missiles and Space Division, Philco Western Development Laboratories, Ford Aeronutronic Division, Republic Aviation Corp., Avco Research and Advanced Development Division, Western Electric Radio Division, International Telephone and Telegraph Federal Division, Bendix Systems Division and Hughes Aircraft Co.

Also invited were Motorola, Western Military Electronics Center, Radio Corp. of America's Astro-Electronics Division, Martin Co., Collins Radio Co., Convair Division of General Dynamics Corp., Page Communications Division of Northrop Corp., North American Aviation Missile Division, Grumman Aircraft Engineering Corp., McDonnell Aircraft Corp., and Loral Electronics Corp.

NATO VTOL Fighter Proposals Await Final Design Specifications

By Cecil Brownlow

Paris—North Atlantic Treaty Organization Requirements Subcommittee is scheduled to meet here in late February in an effort to decide upon final design specifications before seeking formal proposals for its VTOL fighter competition. Meeting, originally scheduled for Jan. 26, is being delayed to allow time for necessary paperwork to be completed beforehand.

Major decision is expected to revolve around the question of whether to change the criteria as laid down in the preliminary requirement to fit more closely with the expected proposals and to take advantage of recent state-of-the-art improvements.

The major proposals expected from Germany, Holland and possibly France apparently exceed most of the basic criteria as now specified. As an example, the Dutch proposal to be submitted by the Royal Netherlands Aircraft Factories-Fokker calls for an "on-the-deck" speed of approximately Mach 1.5. Present NATO specifications require only Mach 0.92.

Some persons associated with the program say, however, that the present requirement should remain unchanged. Any alterations, they contend, could only delay the program without producing a superior design.

Before seeking proposals, agreement also must be reached by the subcommittee and the various nationalities represented on a number of relatively minor items, including specific definitions for terms such as "all-weather," "rough-field capability," etc.

Whatever design is chosen, the program will be West European in scope, with industries of Germany, France, Holland, Belgium obtaining a share of the production. Some of the smaller nations in the project also probably will be helped in meeting their quotas by U.S. Mutual Aid funds as in the case of the present Lockheed F-104G European production program. And whatever design is chosen, the British engine industry seems a sure winner.

The German proposal for a Mach 3 VTOL under development by a three-industry combine, Messerschmitt, Heinkel and Bölkow, envisions use of the Rolls-Royce RB. 153 turbojet engine now under development in cooperation with Maschinen Fabrik Augsburg-Nuremburg.

Basic Features

The design, which incorporates many of the basic features of the Bell D-188A (AW Dec. 5, p. 54), envisions use of either six or eight of the engines which have an estimated dry thrust of approximately 5,000 lb. each and thrust-to-weight ratio of about 16:1. The Mach 2-plus D-188A development would make use of eight General Electric J85-5 turbojets, which have a dry thrust of 2,500 lb. each. The aircraft also would make use of the variable-wing concept as evolved by the National Aeronautics and Space Administration.

The Fokker proposal, also incorporating a variable wing and based primarily on a design supplied by Republic Aviation Corp., is expected to rely upon an advanced version of the 15,000-lb.-thrust Bristol Siddeley BS.53 forward-fan engine as its main powerplant. The BS.53 was developed with U.S. Mutual Aid funds, and U. S. representatives in NATO might feel hard-put not to support a proposal which envisions use of this particular engine.

A possible French entry, based upon a VTOL version of Dassault's Mirage 3 fighter, probably would make use of the 2,130-lb.-thrust Rolls-Royce RB. 108 turbojet, four of which are now powering the Short SC. 1 VTOL research vehicle in Great Britain. The RB. 108 has a thrust-to-weight ratio of about 8:1.

Combined Entry

France and West Germany already have announced plans to "study" and jointly produce a "high performance" VTOL (AW Dec. 26, p. 20) program, and they may make a single entry in the NATO competition. If so, Germany's Mach 3 VTOL is believed to have the upper hand.

Fokker and Republic Aviation engineers are working together in Amsterdam to complete the basic design of the Dutch program. Described as a "unique and completely new aircraft" developed to fit NATO needs, the design is based largely upon the work of Alexander Kartveli, Republic vice president-research and development (AW Aug. 15, p. 64).

Republic, which last spring purchased a one-third interest in Fokker, has been working on various VTOL proposals for the past five years in line with projected U. S. Air Force programs. Kartveli has proposed use of the variable wing on STOL vehicles in the past, but its incorporation into a VTOL design marks a new approach for him.

Tri-Service VTOL

Washington—Letters have been sent to about 30 firms to determine the number interested in entering a design competition for a tri-service VTOL that would be used to learn problems of operating this type of aircraft.

Letters contained some specific information, and detailed specifications will be sent later to a smaller number of companies. Navy's Bureau of Weapons prepared the letter and USAF and Army approved it. The bureau also is preparing the specifications.

First Photo of USAF Cessna U-3B

First of 35 Cessna U-3Bs, similar to civil 1961 Model 310F light-twin business plane, is shown prior to delivery to Strategic Air Command. U-3B features swept tail and other improvements over earlier U-3As purchased by USAF for administrative and light cargo duties. Latest USAF statistics indicate that U-3As, which have been in service since 1957, have logged a total of 298,729 hr. of operation and their average utilization is 61.9 hr./month. USAF's Ballistic Missile Division, Los Angeles, has the highest U-3A utilization —an average of 87.6 hr. monthly. Approximately 160 U-3As are currently in service.

Germans Weigh Turbine Helicopter Decision; Three Aircraft Competing

Bonn—West German Defense Ministry hopes to make a final decision by the end of this month on its future helicopter requirements involving rotary-wing craft in at least three categories.

Probably the largest potential order revolves around a decision in the turbine-powered field, with the Sikorsky S-61, Vertol 107 and the Sud Frelon, a newcomer to the competition, (AW Aug. 1, p. 95), now under consideration.

Defense Ministry said in October that it was deferring a decision until sometime this year between the S-61 and the 107 and would order either the Sikorsky S-58 or the Vertol H-21 as an interim measure (AW Oct. 10, p. 38). Major reason cited at the time of the deferment was the hope that additional orders of one of the two by the U.S. military would result in lower unit costs.

The Frelon has now entered the picture, however, and appears to be a strong, if not leading, contender. Aside from the technical considerations involved, points favoring the Frelon include the fact that such an order might result in a French decision to buy from Germany a number of Sikorsky S-64 Flying Cranes to be built there under license by Weser Flugzeugbau.

Joint R&D Effort

Also, Germany, France and Italy signed an agreement in November, 1958, for joint research and development work on transports and helicopters. Agreement calls for Germany to oversee the smallest and largest types with France and Italy sharing the medium size field. A Frelon order would give added substance to the pact. Under this program, Nord Aviation's C.160 Transall turboprop transport is being built in both France and Germany.

Prototype of the Frelon, powered by three Turbomeca Turmo 3 turbojets, made its first flight in June, 1959. Two prototypes are now rounding out their flight evaluation tests at the Bretigny Flight Test Center near Paris. Maximum speed is quoted at 131 kt., cruising speed at 124 kt. Maximum ceiling is given at slightly over 13,000 ft.

Decisions to buy either the S-58 or the H-21 as an "interim" aircraft are still hanging fire, although in October the Defense Ministry said it hoped to place an order within the next few weeks. Since the S-58 already is operational with West German military forces, it appears to hold a slight advantage if such an order does come through. It is problematical, however, whether either will be ordered.

A Defense Ministry spokesman said last week: "Our troops need a helicopter in this class, but it's a question of whether we want to buy any more piston helicopters in this class or go to jets completely."

HU-1 Considered

The third type of helicopter involved in the review is the Bell HU-1 Iroquois utility helicopter powered by a Lycoming T-53-L-1 powerplant producing 860 shp. The Iroquois, which can be fitted with missile racks to carry the Nord SS.11 anti-tank rocket, has no competitor in this field. The only question is whether to buy or not to buy.

On the positive side, the Defense Ministry has placed a follow-on order for 75 Sud Alouette light turbine helicopters in addition to its contract for 130 of the craft signed last July. Most of the 75 are for use by the army for liaison and scouting chores, but a few will be delivered to the air force.

USAF, FAA Ask Bids For Cargo Transport

Washington—Air Force and Federal Aviation Agency have requested proposals for development of a turbine-powered cargo aircraft for both military and civilian use.

The Air Force will make $30 million available to launch the development program this year. The new cargo transport is the long-range element of the current effort to modernize the Military Air Transport Service, but the aircraft also will be designed to meet FAA requirements so it can be certificated for commercial use.

Specifications for the aircraft include the capability of flying 20,000 lb. of cargo across the Pacific and 50,000 lb. across the Atlantic. Shorter range capacity is to be 70,000 lb. of cargo. Takeoff performance requirement calls for liftoff fully loaded within 6,000 ft. The military version would be equipped for parachuting troops and equipment.

Congress appropriated $50 million in Fiscal 1961 for the new transport development program and $200 million for interim MATS modernization aircraft. The over-all 3% procurement reduced these budgets to $48.5 million and $194 million. With $30 million allotted this year, the Air Force will have $18.5 million left to add to the Fiscal 1962 budget for the development project.

Air Force has given Lockheed Aircraft Corp. a $170 million order for 150 extended range C-130E turboprop transports for interim MATS modernization. The remaining $24 million will be spent next year.

News Digest

Seaboard & Western Airlines' board of directors has elected Lt. Gen. William H. Tunner (USAF, ret.) and Ernest H. Meili, New York banker, to the board. Gen. Tunner retired in May, 1960, as commander of the Military Air Transport Service; Meili is a senior vice president and director of the J. Henry Schroder Banking Corp. of New York. Election of the two new men brings to eight the number of directors now serving on Seaboard's recently revised board.

Loral Electronics Corp. will conduct a six-month technical study for development of a new ballistic missile attack warning system under a Rome Air Development Center contract. Companies working with Loral include Arthur D. Little, Inc., Barnes Engineering Co., and Smyth Research Associates.

Joint Technical Advisory Committee has been asked by Federal Communications Commission to study the controversial problem of frequency allocation for space communications. JTAC is sponsored by the Institute of Radio Engineers and the Electronic Industries Assn.

Electro-Optical Systems, will soon receive a contract from Wright Air Development Division to develop a solar-powered transmitter using an optical Maser, the first USAF effort to prove feasibility of using these new sources of coherent light in a system suitable for space communications.

USS Patrick Henry has deployed to its operating area loaded with 16 Polaris fleet ballistic missiles, becoming the second nuclear-powered submarine with nuclear-armed missiles on duty at sea.

Martin Co. has a $76.9 million Army contract for continued development of the Pershing missile, bringing to $138.5 million the company's Fiscal 1961 contracts for Pershing work.

Navy now estimates that it will cost $47.9 million to complete repairs on the fire-damaged carrier Constellation by December. This is a reduction from original estimates of $75 million, and it involves a delay of seven months instead of the year estimated earlier.

CAB Plays Major Role in TWA Financing

Board's blunt wording in approving finance package terms hints at informal steps to force Hughes action.

By William H. Gregory

Civil Aeronautics Board's strongly worded order approving the Trans World Airlines financing package hints at a previously undisclosed factor in the long negotiations that led to the agreement: that the Board itself had played a major role in forcing Howard Hughes to act last month.

The order bluntly said that the Board's approval would have to be sought if Hughes Tool Co. should attempt to resume control of TWA either prior to or at the expiration of a 10-year trust agreement included as part of the financing plan. Provisions in plan permit prepayment of the loan with penalties.

"It is clear," the order said, "that such approval would not be forthcoming without a searching inquiry into the public interest factors affecting this control."

Furthermore, in a footnote, the order noted that while Board approval is not a condition for dissolution of the voting trust in which Hughes' 78% stock interest has been placed after expiration of its 10-year life, "nonetheless, it is clear that Toolco [Hughes Tool, or in effect, Howard Hughes] should not resume direct control [of TWA] at that time unless prior approval of the Board is sought and obtained."

These warnings are not so much an indication the Board intends to put a permanent end to Hughes control as they are a "sea anchor." That is, the Board is reminding Hughes that it has this authority which could be exercised if circumstances warrant.

The Board, which referred to the substantial problems presented by Hughes Tool control of TWA as exercised through Hughes, began to express its deep concern over the financing situation to the Hughes interests about six months ago.

Few details of the Board's informal representations have come to light, but it is reported in New York financial circles that the Board finally told Hughes that if there was no progress by the end of November the Board would take steps.

Hughes had previously backed out of the Dillon, Read plan that he eventually accepted (AW Oct. 31, p. 35) and had ignored deadlines set by lenders to the point where explicit dates as time limits were given up.

Though the lenders threatened legal action prior to the signing it is a question whether Hughes would have felt forced to respond to this by itself since the lenders might only find themselves as a result owning a fleet of jet airplanes they may not have desperately wanted.

The Board itself does not confirm the setting of any deadline, but it does say that several letters were sent to Hughes discussing the situation. It is evident that the Board made clear to Hughes its view of the Hughes Tool interlocking arrangement with Trans World Airlines as a contingent one, subject to abrogation by the Board if it appeared to have grown counter to public interest.

Abrogation could have meant an immediate crisis for TWA since it could have deprived the airline of the bulk of its jet fleet, then leased from Hughes Tool Co.

Hughes' consideration of a Merrill Lynch, Pierce, Fenner and Smith alternative financial plan that would have involved public sale of Hughes Aircraft stock, now held by a medical foundation of which Hughes is trustee, may have been encouraged by the Board's warning. This might have substantially reduced the Board's jurisdiction by eliminating or reducing a Hughes interest in another aviation enterprise. But there was too little time to prepare the alternate plan.

In the order, the Board comments on the drastic change the financing will make, adding that, "No longer will the directors of Toolco be free to enforce their dictates or those of Toolco's controlling shareholder [Howard Hughes] on TWA."

"The voting trustees will not be restricted in their power to approve further financing for TWA," the order said, "nor in their ability to sell, lease, transfer, hypothecate or otherwise dispose of, or manage TWA's assets. In short, their power to control TWA is as plenary as that of Toolco and its controlling shareholder."

CAB Views

Why the lenders insisted on establishment of the voting trust was not officially told to the Board, the order said. "However," the order went on, "we have not been unaware of TWA's problems." The order then listed:

• TWA, by arranging its financing at a much later late for its jet fleet than its major competitors, will pay substantially higher interest rates than these same competitors. Interest rates in the plan run 6-7% and are regarded by financial sources as 1-2% higher than TWA would have needed to pay two years ago when work on its financing began. Furthermore, TWA is putting up more equity money in rela-

First Modified Electras Back in Service

New York—First modified Lockheed Electra turboprop transports were back in service last week as American Airlines and Eastern Air Lines received them from the manufacturer.

Both airlines said Federal Aviation Agency had advised them speed restrictions on the Electra had been lifted and the original limits restored. But neither airline plans to change its schedules to take advantage of the higher speed limits until further deliveries are made.

Eastern, due to receive its first modified Electra last Thursday, said there would be no schedule changes until all 39 of its aircraft have been modified, probably by the latter part of next July. American will make no changes at least until the spring schedule changeover on Apr. 30. At that time American expects to have about 28 modified Electras out of a 33-aircraft total.

In the meantime, American said the airplane could be operated at higher speeds to make up lost schedule time as occasion demands. American last week had received four modified Electras and had five on the Lockheed line at Burbank. Completion of the American modifications is expected in early June.

The 258 mph. speed restriction was imposed on all Electras last March, following investigation of two fatal accidents which revealed structural failures and led to an extensive modification program (AW Aug. 1, p. 37). Removal of the restriction raises the Electra maximum cruise speed to about 400 mph.

FIRST FLIGHT PHOTO of a Trans World Airlines-marked Convair 880 adds a footnote to the protracted negotiations on a TWA financing program. The picture was taken more than six months ago when the first TWA airplanes were painted but held back awaiting beginning of deliveries to the airline. Since then this airplane, N815TW, has been released to Northeast Airlines as one of six 880s Northeast is leasing directly from the manufacturers (AW Nov. 28, p. 39).

tion to debt than most other carriers, these sources add. The Board expressed its concern in the order at the part the disparity in debt burden might play in the airline competitive picture.

• **Delivery delay** for TWA's Convair 880s appears to have played a substantial part in the airline's inability to maintain its traffic position. "The carrier's preliminary traffic reports for November show that TWA's share of the Big Four domestic passenger market has declined from 23.0 to 20.2%," the order said. "By way of contrast, United, which was behind TWA, has caught and passed it, increasing its share from 21.3 to 29.0%." In a footnote, the order added that American suffered a less severe decline in this period from 32.0 to 30.5%.

• **TWA's major competitors** have taken delivery of much larger jet fleets than TWA is operating and have firm orders for delivery of more. TWA has arranged for acquisition of 47 jet aircraft, the order said, while comparable carriers have acquired or are in the process of acquiring fleets approximately twice this size.

• **Delay may have increased** crew training costs substantially (AW Jan. 2, p. 33). At least one aircraft has suffered from exposure (AW Dec. 12, p. 29) and TWA may be required to pay the cost of restoring it to operating condition.

This question will be negotiated by Convair with Hughes Tool Co., which will take title to 4 of TWA's 24-plane order, and probably with TWA as well. It will be part of the general subject of extra charges, which also includes costs incurred in pulling some of the TWA airplanes off the line at one point.

Because of the strong wording of the Board order, issued the day of the financial closing, and especially the Board's demand that it have prior approval of any Hughes Tool Co. resumption of control, lawyers worried that Hughes might again scuttle the agreement at the last minute. But the closing went off without difficulty.

The Board added that because of the short time between the filing of the application for approval of the transactions and the closing, it could not give the matter the study warranted to resolve the question of jurisdiction satisfactorily. The applicants, TWA, Hughes Tool and the voting trustees—Raymond M. Holliday, representing Hughes, and Irving S. Olds and Ernest R. Breech, chosen by the lenders—have asked the Board either for prompt approval or for a disclaimer of jurisdiction.

"In circumstances such as these," the Board said, "when we do not find the transactions contrary to the public interest, and where the parties do not contest our jurisdiction, it is certainly better to assume jurisdiction and to act promptly so that the parties might proceed to a satisfactory resolution of the business situation."

TWA 880 Service

TWA, which has been delivered a second 880 in addition to one previously at Kansas City for crew training, will put the 880s into service Jan. 12, serving New York, Chicago, Phoenix, Las Vegas and Los Angeles.

The initial schedules:

• **Flight 147:** Depart New York (Idlewild) 9 a.m., arrive Chicago (O'Hare) 10:05 a.m. Depart Chicago 10:35 a.m., arrive Phoenix 12:40 p.m. Depart Phoenix 1:10 p.m., arrive Los Angeles 1:10 p.m. (All times local; Phoenix-Los Angeles flight time 1 hr.).

• **Flight 146:** Depart Los Angeles 7:20 a.m., arrive Phoenix 9:25 a.m. Leave Phoenix 9:55, arrive Chicago 1:30 p.m. Depart Chicago 2 p.m., arrive New York 4:35 p.m.

• **Flight 143:** Leave Idlewild 4:30 p.m., arrive Chicago 5:35 p.m. Depart 6:05 arrive Las Vegas 7:25. Depart 7:55, arrive Los Angeles 8:40 p.m.

• **Flight 148:** Depart Los Angeles 11:40 a.m., arrive Las Vegas, 12:30 p.m. Depart 1 p.m., arrive Chicago, 6 p.m. Depart 6:30 p.m., arrive Idlewild 9:05 p.m.

TWA will need a minimum of four airplanes to begin this schedule, which has no interlocking features for higher utilization. TWA, conscious of the competition in the Chicago market cited by CAB, established the schedules for most favorable departure times from there to Phoenix and Las Vegas where the winter season is getting under way.

Five airplanes in addition to the two delivered are either in acceptance flights or undergoing customer inspection at San Diego. TWA expects to have nine airplanes all told by the end of February.

TWA's second 880, the first delivered under the new financing plan, is production airplane No. 31, serial number N824TW. The first ship now painted after flying in training unmarked, is the fifth production airplane serial number N804TW.

CAB Dictation of Airline Service Criticized in Senate Staff Report

By Katherine Johnsen

Washington—Congressional inquiry into Civil Aeronautics Board's recent moves toward specifying the type of equipment airlines are to use and the type of service they are to provide was termed imperative last week in a report by the staff of the Senate Commerce Committee.

In cases involving Ft. Worth, Toledo, Flint-Grand Rapids, and Baltimore, courts have upheld the Board's authority to dictate to the airlines such specifics as whether service shall be coach or first class, the scheduling of flights, and the type of equipment to use. Capital Airlines' case on service to Baltimore is pending before the Supreme Court.

Unless the Supreme Court reverses lower courts or there is congressional action, the report said that CAB's control over airlines may "snowball" and result in government control of "virtually every phase of the air transportation business." The report said that "we ought not blindly stumble" into such a situation without weighing alternatives. "We could lose the advantage of election of alternative courses if the question is not answered soon," it said in calling for the Congressional investigation.

The report also recommended establishment of a Department of Transportation, a Federal Transportation Commission, a Joint Congressional Committee on Transportation, and a Transportation Circuit Court of Appeals.

The objective would be government direction over all forms of transportation by the same agency. Federal Aviation Agency would be incorporated in the Department of Transportation, the Civil Aeronautics Board in the 15-member Federal Transportation Commission.

Removal of present bars to ownership of air transportation companies by railroads and shipping companies was also recommended in the staff report. Joint ownership would be left to the discretion of the regulatory commission.

The report viewed favorably the establishment of "transportation companies"—single corporations which would operate various modes of transportation—but it said that this is an improbable development. "Competition between transportation companies probably would be more intense than is the case between carriers of the same and different modes today," the group commented.

The statement of national transportation policy proposed in the report, which would supplant the policy objectives for the independent development of aviation stated in the Federal Aviation Act, would provide: "Flexible, coordinated, and impartial promotion and regulation of all modes of transportation. . . . so as to provide for recognition, development, and full realization of the relative advantages and characteristics of each mode. . . ."

The Commerce committee staff has been studying national transportation for the past year and a half, and it consulted with 33 ad hoc committees of private transportation users and operators and an advisory council of 32 transportation associations, including Air Transport Assn., Association of Local Transport Airlines, Air Cargo Carriers, and Independent Airlines Assn. The study was an outgrowth of an investigation of the railroad industry. After considering the financial and other problems of the rails, the committee decided to broaden its investigation to all forms of transportation and their inter-relation. The major recommendations of the staff report reflect the position that has been held by rail interests for over a decade.

Additional recommendations were:

• **A program of user charges** to finance the federal airways should be promptly initiated. The objective should be to have users, including the military services and other government agencies as well as commercial and private operators, fully finance airways costs within 10 years. The costs would include construction and operation of the airways system, grants for airport construction, and Weather Bureau aids. The report estimated that these costs will total $611 million for 1961, and mount to $1.1 billion for 1970.

It proposed that the $58 million revenue from aviation gasoline taxes now in the Highway Trust Fund be transferred to a new Airway Trust Fund, which would be established specifically to finance airways costs.

• **The two cents a gallon tax** on aviation gasoline should be levied also on jet fuel by the Treasury Department. The report said legislation is not required. As jets are added to airline fleets, it was estimated that tax revenue from aviation gasoline will decline from $23 million in 1961 to $16 million in 1962, and to $8 million in 1963.

• **Government agencies,** such as Military Air Transport Service, should pay "fair and reasonable rates" as determined by a regulatory agency—not as determined by the agencies themselves.

• **Unregulated competition** should not be permitted to "materially compromise" the ability of regulated common carriers which are the "hard core" of the national transportation system to perform proper service.

The report projected an expenditure of $75 billion by the federal government for transportation aids over the next 15 years: $42 billion for highways; $19 billion for aviation; $12 billion for navigation; and $2 billion for merchant marine subsidies.

Airlines Oppose Plan For Credit Changes

Washington—Strong opposition to any Civil Aeronautics Board move to alter the existing scheduled airline credit plan was raised last week by 17 carriers and two credit card companies.

Industry concern was aroused when the Board's Bureau Counsel recommended that a 2% service charge, plus a 1% charge for any bills paid beyond a 30-day deadline, be imposed on users of the Universal Air Travel Plan or any other credit card arrangement honored by the airlines. The CAB attorneys also favored dropping the present UATP deposit from its current $425 to $100.

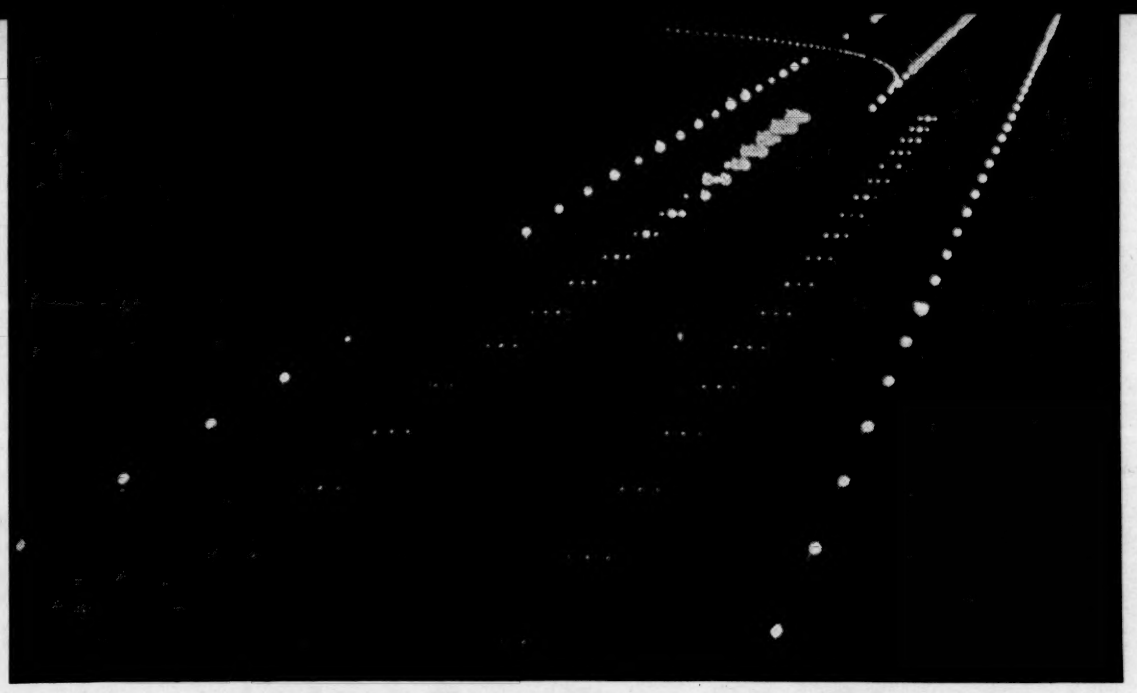
Reaction to the bureau counsel recommendations was generally opposed to any changes, but it varied on the basis of whether the airline recognized only the UATP or any combination of plans.

United and American Airlines both objected to the Bureau Counsel findings and criticized any attempt to recognize any plan other than UATP. The airlines contended that credit plans, such as those offered by the Diners' Club, the Hilton Corp. Carte Blanche arrangement or the American Express Co., do not promote traffic and add bookkeeping expense to the airlines.

United pointed out that user charges levied by American Express are 2%; the Hilton and Diners' Club plans cost the carrier 4% and the Bank of America surcharge amounts to 6%, "all of which comes out of the fare charged" reducing the airlines' income.

Continental Airlines, which uses the UATP plus American Express, Hilton and the Diner's Club, generally supported the Bureau Counsel findings, but urged that any late payment charge be extended over at least 60 days.

While opposing any surcharges to any credit plan, both American Express and Hilton criticized the deposit requirement of the UATP as being useful only to the "high volume, big business accounts" and discriminating against people unable to afford UATP.



Lighted Turnoffs at Idlewild

Highspeed turnoff Elfaka lights can be seen in this night photo of Idlewild International Airport runway. Lights are installed flush in center of the taxiways; first turnoff lights begin 3,300 ft. from the runway threshold and second at 5,600 ft. The lights were installed by Structural Concrete Products Corp. of New York. Two high speed lighted turnoffs also are available on the right side of the runway for traffic landing in the other direction.

Agency Reorganization Proposals Submitted

Washington—Blueprints for tighter controls over reorganized federal regulatory agencies continued to increase last week as two more plans were published in the wake of James M. Landis' appointment as White House overseer of these agencies for the Kennedy Administration.

Recommendations of the House Legislative Oversight Subcommittee and initial plans for the formation of an Administrative Conference of the United States to advise the President on regulatory problems were added to similar studies submitted earlier by the Bureau of the Budget and Landis.

Landis will serve as special assistant to the President and will plan the reorganization of the regulatory agencies promised by President-elect John F. Kennedy. The job is new and is described as temporary. It is somewhat similar to the more powerful permanent overseer of federal regulatory agencies recommended in the Landis report (AW Jan. 2, p. 28).

The Administrative Conference, proposed by Judge E. Barrett Prettyman of the U. S. District Court of Appeals as a result of earlier talks between the White House and regulatory agency executives, would be composed of 65 delegates, 40 of them selected from the various government departments and agencies and the balance from 20 non-government sources such as bar associations, plus five specialists in the fields of accounting, geology, and economics.

The conference would meet twice a year to discuss findings of eight standing committees on personnel standards, agency proceedings, operations, statistics and reports, economic surveys, information and education, agency jurisdiction and judicial review. Members of Congress would be invited to attend conference proceedings, which would be reported twice a year to the White House, Congress and all agency heads, including the Federal Aviation Agency and the Civil Aeronautics Board.

The report released by the House subcommittee majority called for administrative changes in the operations of regulatory agencies, particularly relating to ex parte contacts with industry. For important cases, the report favors assigning responsibility for handling each case to an individual member of the board or commission involved. The subcommittee, which officially went out of business last week, recommended continued congressional surveillance over the agencies.

President-elect Kennedy now has a variety of plans to choose from in any move to revamp the authority or powers of the regulatory agencies, but most observers feel his selection of Landis as a regulatory overseer indicates his intentions to adopt the Landis plan. Basic strength of the Landis plan lies in the kind of office to which Landis has been appointed.

Delta Will Comply With Jet Noise Rule

New York—Port of New York Authority has withdrawn its suit against Delta Air Lines aimed at forcing Delta to comply with the agency's anti-noise regulations at New York International Airport (AW Oct. 31, p. 36).

Delta, deciding not to make a precedent-setting test case of the action, had promised to comply with the rules and had asked for an extension of the original deadline for replying to the charges in court. According to the Port Authority, Delta since has had a "virtually perfect" record of compliance with the jet noise rules. Since the suit was filed last Oct. 26, the agency said, Delta as of Dec. 30 had made 263 jet takeoffs with only five violations. Previously, from January through September, the airline made 841 jet takeoffs with 220 violations, the authority said.

Alaska MATS Fares Supported by Board

Washington—Civil Aeronautics Board has upheld new low-rate Military Air Transport Service single-ticket fares Alaska Airlines will charge for military personnel traveling on official business between Seattle, Wash. and Fairbanks and Anchorage, Alaska.

The new fares, called Category A rates permit Alaska Airlines to offer MATS individually ticketed seats at 2.9 cents per passenger mile on an experimental basis, a rate usually charged for MATS plane-load charters. The Alaska Airlines fare is 53.4% lower than Pan American World Airways' rate on its Seattle-Anchorage route and 40% lower than Pacific Northern Airlines fares on the same route.

CAB rejected Pan American and Pacific Northern complaints that the fares set by Alaska were too low. Pacific Northern said it could not compete with the service because it is not a member of Civil Reserve Air Fleet. The carrier flies Lockheed 749 Constellations, aircraft not recognized by MATS in the CRAF program. Pan American said that as long as Alaska is on federal subsidy, the new rate constitutes "unfair competition since no unsubsidized airline could afford to sell seats to MATS for 2.9 cents per passenger mile."

Alaska said the low fare will give it added revenue by filling seats that would be empty anyway and alleged the Category A fares are applied to passengers who would not move over Pan American or Pacific Northern routes in any case.

Board Member John S. Bragdon dissented. He said: "The 2.9 cent rate was fixed as a minimum for MATS plane load traffic, not for individually ticketed traffic." He said use of such a rate in an isolated experimental case was "unsound" because it could not be acceptable on an industry-wide basis or by an individual company that "wished to remain long in business."

The 2.9 cent per passenger mile rate will be used by Alaska until June 30, when it will then present complete and appropriate records of traffic and financial results to the CAB on its MATS operation.

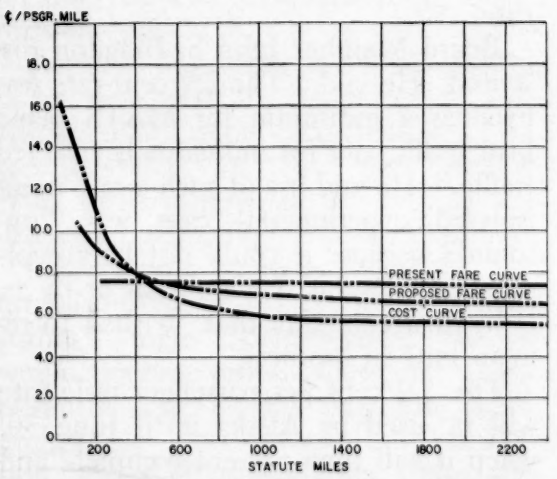
THREE aircraft types used by Trans-Canada are the Conway-powered Douglas DC-8, and Vickers Vanguard and Viscount turboprops.

Canadian Fares Based on Turbine Costs

By L. L. Doty

Montreal—Adoption of an economy fare as a basic rate pegged to the operating costs of an all-turbine fleet is the key to the revamped fare structure developed by Trans-Canada Air Lines and now in effect throughout Canada's scheduled airline system.

The new rate concept, the result of exhaustive cost and earnings studies, represents the first attempt to eliminate obsolete and cumbersome rate patterns based on railway and DC-3 operations by designing a structure specifically fitted to modern turboprop and turbojet aircraft. The new fares are expected to result in deeper inroads into long-haul railroad passenger traffic and could become a serious competitive weapon against U. S. carriers on transcontinental routes between New York and the Pacific Northwest.



COST CURVE shows the rate pattern that penalizes the passenger on short-haul routes with higher rates.

Essentially, the rate pattern follows a cost curve (see chart) that penalizes the short-haul passenger with somewhat higher fares than former rates but provides the long-haul passenger with a rate slightly lower than current rail rates and substantially less than fares charged in U. S. tariffs.

Comparative Fares

Air economy one-way fare on Canadian scheduled airlines between Vancouver and Montreal is $110, compared with a current rail fare of $115.40. Economy rate between New York and Vancouver is $115 on Canadian airlines, but a round trip excursion rate effective Oct. 1 to May 31 on light traffic days—Monday noon through Wednesday—provides passengers with a $106 one-way rate between the two cities. Lowest one-way fare on U. S. carriers between New York and Vancouver is $118.20 on piston-engine aircraft. Lowest one-way turbojet fare between the cities is $138.60.

The new fare structure on Canadian routes does not include a fare differential among turbojet, turboprop and piston-engine equipment, so passengers can ride jet flights at the economy rate. In addition, Canadian fares are not subject to tax, while U. S. carriers have to charge the 10% federal transportation tax.

Philosophy behind the revised fare is that it is uneconomical to carry short-haul passengers, that ground transportation is becoming increasingly competitive over short distances and that low fares on short-haul routes will not lure passengers to air travel in sufficient numbers to offset the heavy cost of handling short-haul traffic.

In addition, TCA has reasoned that the long-haul passenger was helping to pay a part of the cost of handling short-haul passengers by virtue of the relatively high long-haul rates. Thus, the new fare structure is aimed at the long-haul market with the purpose of bringing a substantial increase in revenue passenger miles in that market, although the gain in the number of passengers carried system-wide will not be as spectacular.

Here are the assumptions and principles on which TCA based the reworking of its rate structure:

• **Economy fares** will be available on all routes between all points under the new fare pattern. First-class rates will be superimposed only on route segments which have demonstrated a need or de-

Lower Cargo Rates

Montreal—Trans-Canada Air Lines will file a cargo tariff developed along the lines of its revised passenger rate pattern as an experimental project. The tariff has been worked out on a commodity basis and will provide substantial cuts on commodities particularly adaptable to air transportation. Cargo traffic has been slow in developing in Canada compared with the U. S., but according to one TCA official here, "the pattern is improving rapidly." Greatest growth in international cargo traffic out of Canada has been on transpacific routes.

mand for the first-class service.

• **First-class and economy** round trip discounts will be eliminated. All tariffs will be published in even dollar amounts.

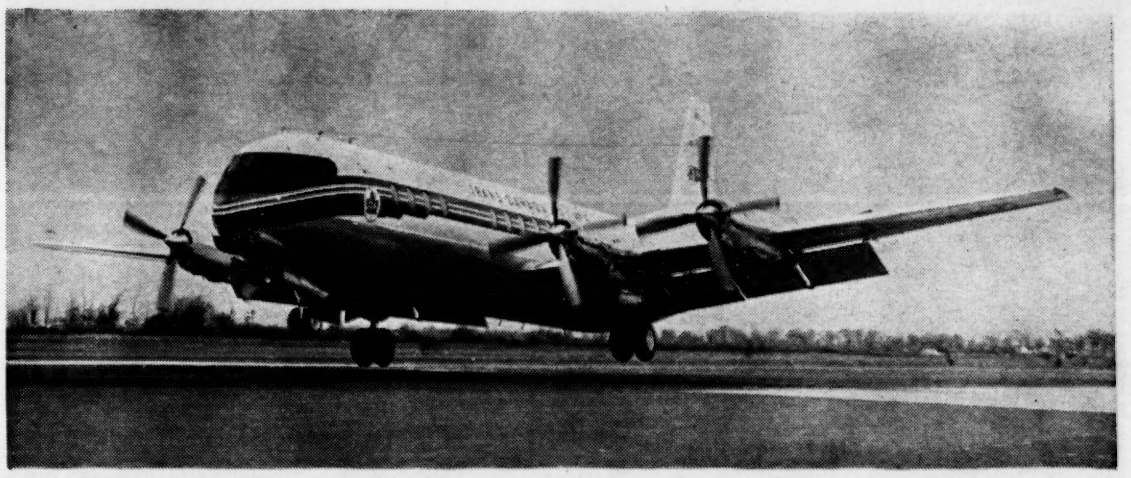
• **Economy fares generally** will be 66% of first-class rates, and no charge will be made for stopovers.

• **Family plan,** which in Canada allowed a 50% discount on tickets used by members of a family traveling with the head of a family holding a first-class ticket, will be eliminated. Discounts for convention travel, commercial travelers and charter groups will be eliminated. TCA wants to discourage domestic charter services whenever possible and will urge groups to use regularly scheduled service.

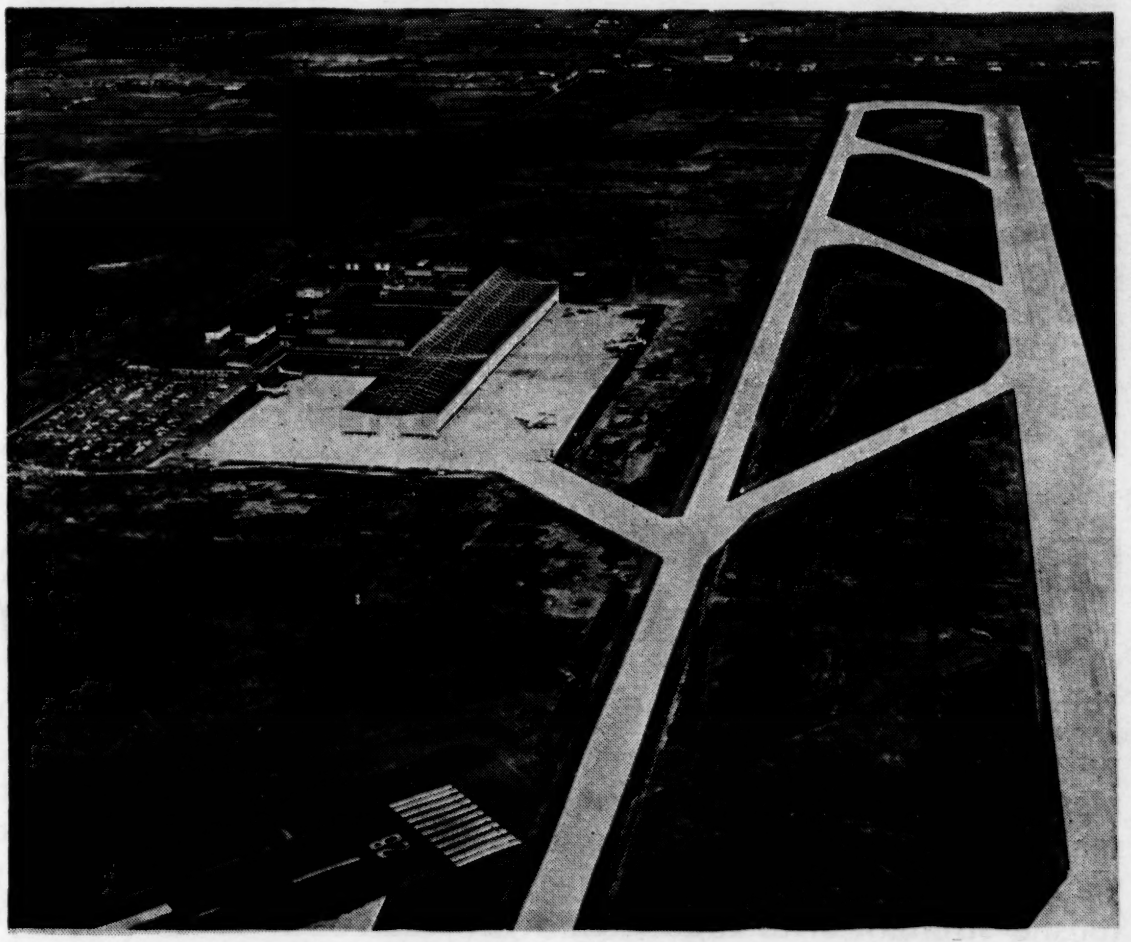
• **All surcharges** will be eliminated, and a minimum fare of $7 one-way, $14 round trip will be established. A prime goal in developing the new fare structure was simplicity, including removal of the complexities of a pyramiding of special inducement rates, as a means of improving accuracy, speed and efficiency at ticket counters.

• **Short-haul rate** per mile will vary inversely with rate per mile for longer distances. To achieve this, short-haul rates will be increased, long-haul rates will be decreased.

TCA studies revealed that generally, the ratio between tourist and first-class traffic throughout Canada is currently 80-20 or, as one TCA official put it, "we found that 80 out of 100 people are dictated by their pocketbooks to use the lowest fare available." He added that the ratio on the route between Canada and the United Kingdom is 90-10. In the U. S., the ratio is now 77-23 on long-haul routes, but it is gradually progressing toward an 80-20 figure, he said.



TCA Vickers Vanguard will fly the airline's medium-haul routes, carrying 96 passengers.



NEW Trans-Canada overhaul facility at Montreal's Dorval Airport connects with new runway.

All-Turbine Operation

TCA will move into an all-turbine fleet operation this spring, meeting a target date first forecast to AVIATION WEEK almost five years ago (AW June 19, 1956, p. 38). The fleet will consist of 49 Vickers Viscount turboprop transports, 11 Conway-powered Douglas DC-8 transports and 23 Vickers Vanguard turboprops, three of which had been delivered as of last week.

The Viscount will cover all short-haul routes. To reduce cost per seat mile, the number of seats have been increased to 54 from 40 in a five-abreast configuration to increase operating efficiency by 22%. Vanguards will cover all medium-haul routes with 46 first-class seats and 50 economy seats, while the DC-8 will operate long-haul routes with 28 first-class seats, 99 economy seats.

This is the fleet to which the fare structure has been keyed, and it is expected to serve the airline through 1965.

TCA President Gordon R. McGregor told AVIATION WEEK that his company would not be in the market for medium-range jets until 1965 when a complete selection of second generation medium-range transports will be available.

During 1963 and 1964, he said, selection will be limited to the Convair 990, de Havilland 121, and the Boeing 720B. By 1965, he added, available inventory will be increased to include the Vickers VC-11, the de Havilland 121 Mark II and the Boeing 727. He said he is not interested in two-engine aircraft and will probably hold to the four-engine concept when the time comes to make a decision.

Medium-Haul Competition

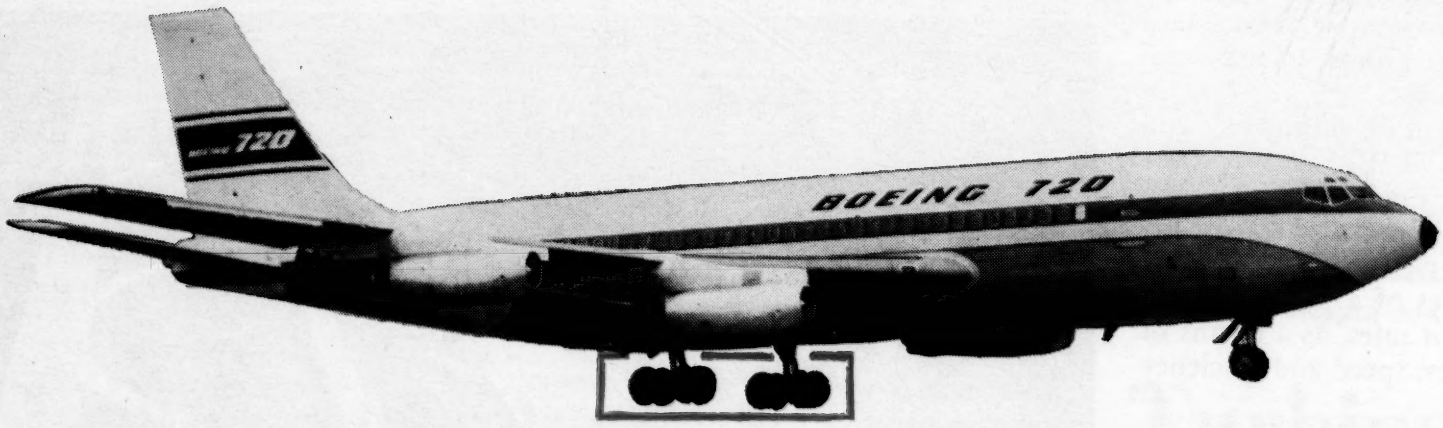
McGregor said he is looking forward to medium-range turbojet competition against his turboprops with some "uneasiness" but added that he felt the situation can be met during 1963 and 1964 by moving some DC-8 operations into major medium-haul routes.

McGregor doubts that there is a future for turboprop equipment on long-haul routes but said the economies of the airplane will keep it in service on short-haul routes for some years to come. In addition, he said the low operating costs of the Vickers Vanguard will enable it to encroach on some of the routes served by the Viscount and the DC-8. In fact, he added, the Viscount fleet will probably be reduced to half its present size by 1965 as the Vanguard's high seat capacity is used to a greater extent on short-haul as well as medium-haul routes.

TCA's cost curve was derived from operating costs and earning capabilities of a composite aircraft drawn from the 1961 fleet of DC-8s, Vanguards and Viscounts. McGregor admitted that some variation in the cost factor may appear as more operating experience with the DC-8 is gained.

He said the development of long-haul traffic is largely dependent on low fares, adding: "air travel is surprisingly sensi-

CAMERON
AIRCRAFT FORGINGS



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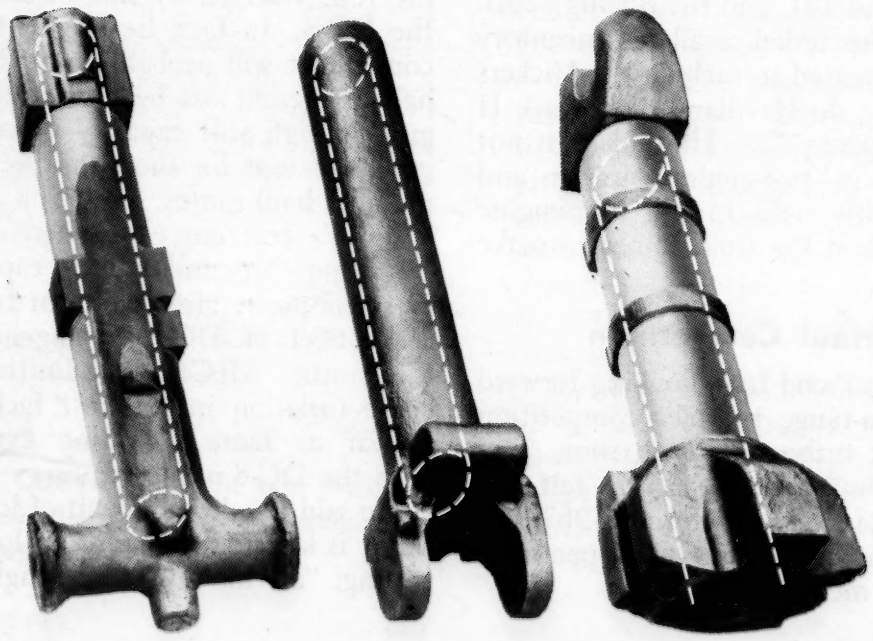

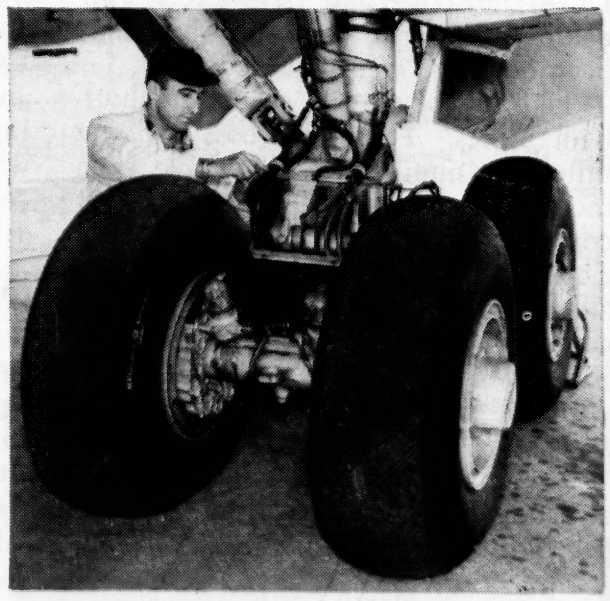

TRANS-CANADA AIR LINES has taken delivery of four Vickers-Vanguard Type 952 turboprop transports and expects to begin scheduled flights next month. On Feb. 1, one daily Vanguard flight will connect Vancouver, Calgary, Regina, Winnipeg, Toronto and Montreal, and another daily flight will begin serving Vancouver, Edmonton, Saskatoon, Winnipeg, Toronto and Montreal. On Feb. 15 a daily flight will be introduced connecting Toronto, Montreal, Moncton, Halifax, Stephenville, Gander and Saint John's, Newfoundland. On Apr. 1, a daily flight will begin flying between Toronto, Montreal, Saint John (New Brunswick) and Halifax. Trans-Canada eventually will fly Vanguards from Montreal to Bermuda, Antigua, Barbados and Trinidad.

tive to fares." However, he said that the very short-haul rates could have been increased more than they were rather than having been eased downward, as they were, from the cost curve in the high-cost, short-haul area of the chart.

For example, the cost curve shows that cost of operating scheduled service between Montreal and Ottawa is $13 one-way, $26 round trip. This service was being offered at $7 one-way, $14 round trip for first-class passengers. The new economy rate is the same as the old first-class fare, but the new first-class fare is $10 and $20, both fares being far short of operating costs.

Costs are fully covered by the new low fares on long-haul routes, however. Former tourist fare between Toronto and Vancouver was $110 one-way, $220 round trip against a cost of $76 one-way, $152 round trip. New fare is $99 and $198 respectively.

Thus, TCA has ensured itself an operating profit on long-haul routes but will continue to lose on its short-haul operations. However, tariff experts reasoned that an attempt to match fares on short-haul routes with operating costs would force too large a portion of present business to surface transportation. The break-even point has been set at about 400 route miles. Beyond that, the carrier will begin to realize an operating profit, which stresses the carrier's need to concentrate its sales efforts in long-haul markets.

W. Gordon Wood, TCA vice president-sales, directed the tariff project. J. E. Nickson, general sales director, coordinated the program and supervised the work on the cost curve, which was developed by N. E. Taylor, chief of economic research. New fares between all points and combinations of points were constructed by G. R. Wilson, director of passenger sales and Jack Lane, assistant to sales director.

New York Airways Plans Turbine Service

By Glenn Garrison

New York—New York Airways, which has been flying the prototype Boeing-Vertol 107 in familiarization exercises and demonstrations, expects to receive its first production model of the twin-turbine helicopter next April and to begin operation of its fleet in early June.

These target dates are based upon the assumption that the certification program on the 107 will continue at the present rate. The first five units of New York Airways' total order of 10 will go into service at the same time, replacing the present fleet of five Vertol 44Bs. The other five of the 25-passenger 107 helicopters will be delivered as traffic indicates, according to New York Airways President Robert Cummings. The present 15-passenger 44Bs will be traded in for credit on the new aircraft.

Cummings told AVIATION WEEK that expected performance of the 107 offers a potentially subsidy-free operation, whereas the 44B represents "stagnation" and no hope of ending subsidy. New York Airways has applied to Civil Aeronautics Board for a guaranteed loan to cover the first five 107s.

The carrier's figures show that each 44B at 50% load factor and 3 hr. daily utilization shows a deficit of $130,000 annually in direct operating costs, plus all indirect costs. On the other hand, the 107 under the same conditions would pay all its own direct operating costs from commercial revenues and also contribute about $115,000 toward the indirect costs. At 5 hr. daily utilization, which is closer to New York Airways' actual operation, the 107 would pay its direct costs and $310,000 of indirect costs, Cummings said. A fleet of 10 units therefore is expected to provide a subsidy-free operation.

Operating Costs

Direct operating costs per available seat mile with the 44B are 31 cents, according to the airline's figures. With the 107, this cost is expected to be about 12 cents.

New York Airways pilots have flown the tandem-rotor 107 prototype over all the carrier's routes, for familiarization and various tests including noise levels and obstruction clearance at lower altitudes. The aircraft now is back at Vertol. The prototype, powered by Lycoming T53 turbine engines as opposed to the more powerful General Electric T58 which will power the production models, is fitted with only seven seats and is in a partial cargo configuration. With the seven seats occupied, average cruise speed around the New York area has been about 120 kt.

For the first time, according to Cummings, it will be possible to operate with vertical takeoff capability instead of the takeoff roll necessary with the single-engine piston H-44B. This feature will be of utmost importance in serving community center sites, making it possible to discuss such operation "rationally and economically," Cummings said.

The airline recently applied to CAB for a route between New York and Philadelphia, which would be served

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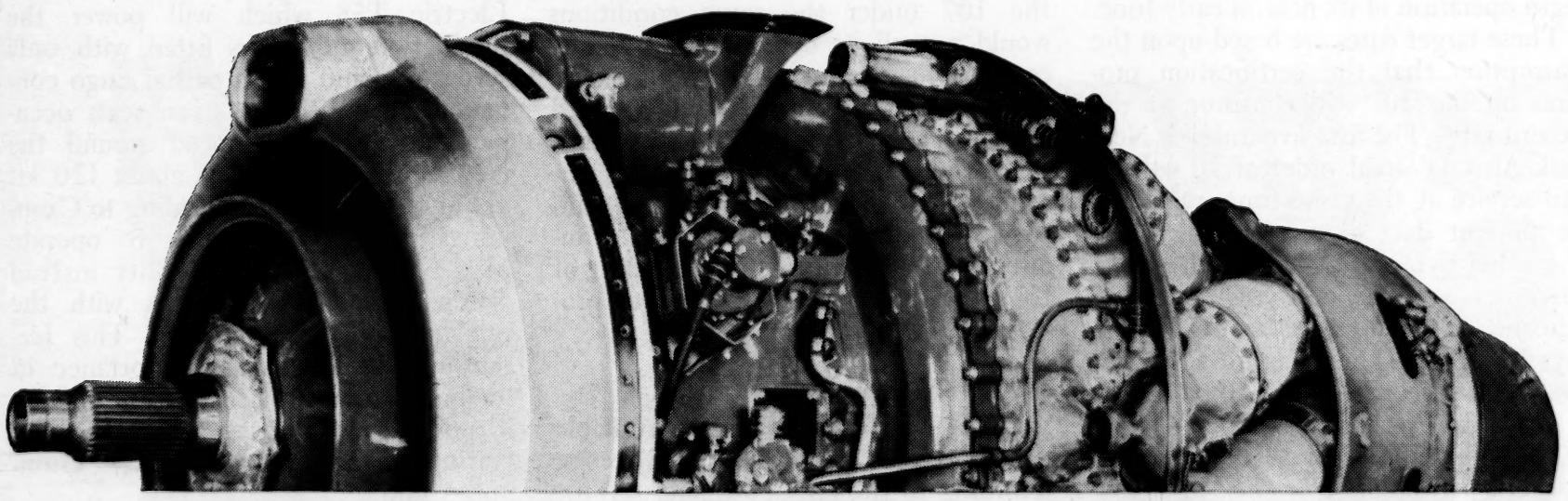

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NEW YORK Airways prototype Boeing Vertol 107 circles lower Manhattan after dedication of downtown heliport last month.

from two new heliports opened last month. At the New York end, the Port of New York Authority opened a facility at the foot of Wall St. in Manhattan. In Philadelphia, the city opened a heliport at Pier 8 between Walnut and Chestnut Streets.

If approved and inaugurated, this service between the first and third largest U.S. cities would involve a scheduled time of 32 min. Cummings said hourly service is under consideration with a fare of about $15. An additional three aircraft would be needed to provide the service.

Washington Service

Another New York Airways application concerns the proposed new Washington, D. C., area service (AW Dec. 19, p. 49). If New York Airways were the successful applicant, it might form a subsidiary to provide the service, either using a common fleet or with different aircraft for Washington.

A novel feature of New York Airways' 107s will be an interchangeable baggage compartment. This watertight unit forms the rear fuselage section of the helicopter, can be detached at a stop and replaced with a loaded compartment for the next segment. Advantage, of course, is the time saved in loading baggage at a stop. One minute saved at each stop could boost annual revenues by 10%, Cummings said. The detachable compartment will involve a 300-lb. weight penalty but is expected to more than make up the difference in time savings.

The 107 will make possible a 95% schedule reliability, compared with 80% reliability with the 44B, Cummings said. An example of the operating improvement is the Stamford, Conn., stop, where the 44B is limited to six passengers on a 90F day to maintain performance over obstacles. In VFR conditions, the 107 will be able to operate from Stamford at full 25-passenger payload on a 90F day, Cummings said. Under IFR conditions, the load would be 21 passengers at that temperature.

In addition to the improvements two turbine engines will offer over a single piston engine, the tandem-rotor configuration of the 107 is strongly favored by New York Airways, according to Cummings. He said the airline has evaluated both single- and tandem-rotor systems in its operation. Cruise speeds up to the present have not pushed the aerodynamic limits of the rotor blade, but even so, blade stalls have sometimes been encountered at high weights and high temperatures. With the tandem system, Cummings said, it is still possible to get the blade stall but there is no loss of control. Also with the tandem rotors, there is protection against a possible stalling under power condition at low speed while descending.

These factors bear heavily on the vertical takeoff possibilities, Cummings said, and vertical takeoff will be an operational and economic necessity for some community center services.

New York Airways expects the passenger total for 1960 to be 150,000. Five 107s at 5 hr. daily utilization will quadruple seat-mile production, Cummings said.

Passenger Total Tops 100 Million in 1960

Montreal—Scheduled airlines of the world exceeded the hundred million mark in passengers carried last year with a total of 108 million for 1960, a 10% increase over 1959's total, according to an International Civil Aviation Organization report.

Reflecting the large-scale introduction of jet aircraft, the number of hours flown for the two years remained constant: a total of 8.9 million hours for 1959 and for 1960. Passenger miles flown in 1960 totaled 69 million, an increase of 14%. Average number of passengers carried per aircraft, according to the ICAO report, was 35 in 1960, up from 32 in 1959. Average length of passengers' trips was 640 mi., up from 618 mi. Cargo ton miles totaled 1,495,000,000, up from 1,315,000,000.

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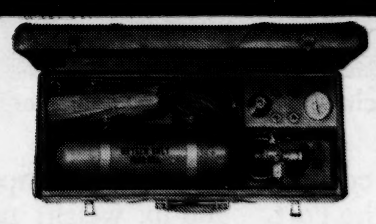

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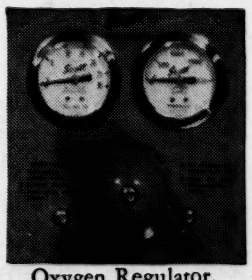

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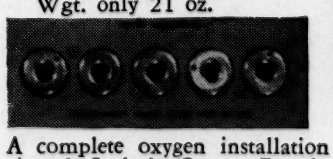

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Examiner Favors United-Capital Merger

Washington—Proposed merger between United Air Lines and Capital Airlines moved a step closer to final Civil Aeronautics Board action when Examiner Thomas L. Wrenn recommended blanket approval of the carriers' plan.

Wrenn's report came in time to permit the Board to make its decision close to the Feb. 1 deadline urged by United and by Vickers-Armstrongs, Ltd., which is threatening to foreclose on Capital. It is unlikely that a full written opinion can be prepared by early February, but a press release could be issued announcing the decision.

On the premise that approval of the merger pact would avert a layoff of 7,600 Capital employes while ensuring improved service over the carrier's routes, Wrenn said the "balancing of pros and cons" in the case "leaves no doubt that approval of the merger will better serve the public interest."

CAB promised expedited handling of the merger case, and Wrenn carried it from the pre-hearing conference stage to his recommended decision in 15 weeks. Studying the examiner's report last week, Board members said they would make every effort to take action by Vickers' Feb. 1 deadline, after which the British company has threatened to go ahead with foreclosure action to collect the $34 million Capital owes on its Vickers Viscount fleet. But one Board member conceded that "this is a terribly close run."

Exceptions to the examiner's decision and briefs to the Board will be filed by Jan. 20, after which the CAB will have to study the evidence, hear oral arguments and reach a decision. It is unlikely that Vickers would refuse a slight extension of its deadline in view of the expedited action thus far and the strong recommendations for approval, which Vickers favors, made by the examiner. An announcement of the Board's decision undoubtedly will precede its formal opinion because of the time required to write the opinion.

Meanwhile, United has extended until Jan. 28 the deadline for exchanging shares of its common stock for Capital's subordinated debentures at the rate of 20.6 shares for each $1,000 valuation of debentures. Part of the agreement provides that United may abandon the merger if at least 85% of the debentures are not exchanged for stock. Last week, a total of 31% had been deposited with the First National City Trust Co. of New York for exchange.

Examiner Wrenn's decision was literally a blanket adoption of all points of the merger agreement already approved by the stockholders of both airlines and a detailed rejection of all objections raised by intervening airlines.

In his 115-page initial decision, Wrenn said: "The hard fact which cannot be ignored is that without approval of the merger it is unlikely that Capital will be able to maintain operations of any kind but instead will go into bankruptcy and liquidation, unless in the unlikely possibility, the federal government should agree to finance the operation through a reorganization by subsidy and guarantee of loans or an outright financing of the acquisition of new equipment."

Labor Protective Clauses

Attached to the initial decision were nine pages of labor protective clauses which have customarily been applied in past CAB merger approvals. Provisions are required for the fair integration of seniority lists, a guarantee of equal work duties and salaries for those retained in the merged company and a sliding scale of dismissal allowances for employes dismissed as a direct result of the merger.

Payments under this allowance would be made on the basis of 60% of the employe's average salary for the past 12 months and would be paid for a period of six months for those with a year of service or less. Allowances range up to five years pay for those with 15 or more years of service.

Arguments by Northwest and Delta that approval of the merger would amount to creating a monopoly over 19 air traffic markets in which Capital and United are the sole competitors were termed "academic" by Wrenn. He pointed out that should Capital be forced into bankruptcy, United would become the only unrestricted air carrier in those markets and would do so without any expense involved. The record indicates that the merger will provide this market area with "better, not poorer" service, he said.

In further discussion of the monopoly question, the examiner pointed out that during the original writing of the Civil Aeronautics Act, Sen. Harry Truman noted that, "We want to write it so that there will be no monopoly, but we do not want to put the airlines in a straightjacket so that if a weak line, which was of service to the public, was about to blow up, a strong one could not take over and keep it in operation."

The major concern behind the objections of both Delta and Eastern is not a matter of traffic, but "arises out of a fear of too much competition" over Capital's Route 51, particularly the segments including New York-Atlanta-New Orleans and Atlanta-Florida, Wrenn said.

Statements by Delta, Eastern and Northwest, the examiner said, show that they oppose the merger because of the "windfall" they would receive if the merger were rejected and Capital were liquidated. Delta would lose a competitor over its New York-Atlanta-New Orleans route; Eastern would get rid of a competitor over the same route plus becoming the only airline in the Cleveland-Pittsburgh-Miami market, and Northwest would gain full control over the Twin Cities-East Coast market and a monopoly over Capital's Route 14 between Detroit-Cleveland-Pittsburgh and Washington, he pointed out.

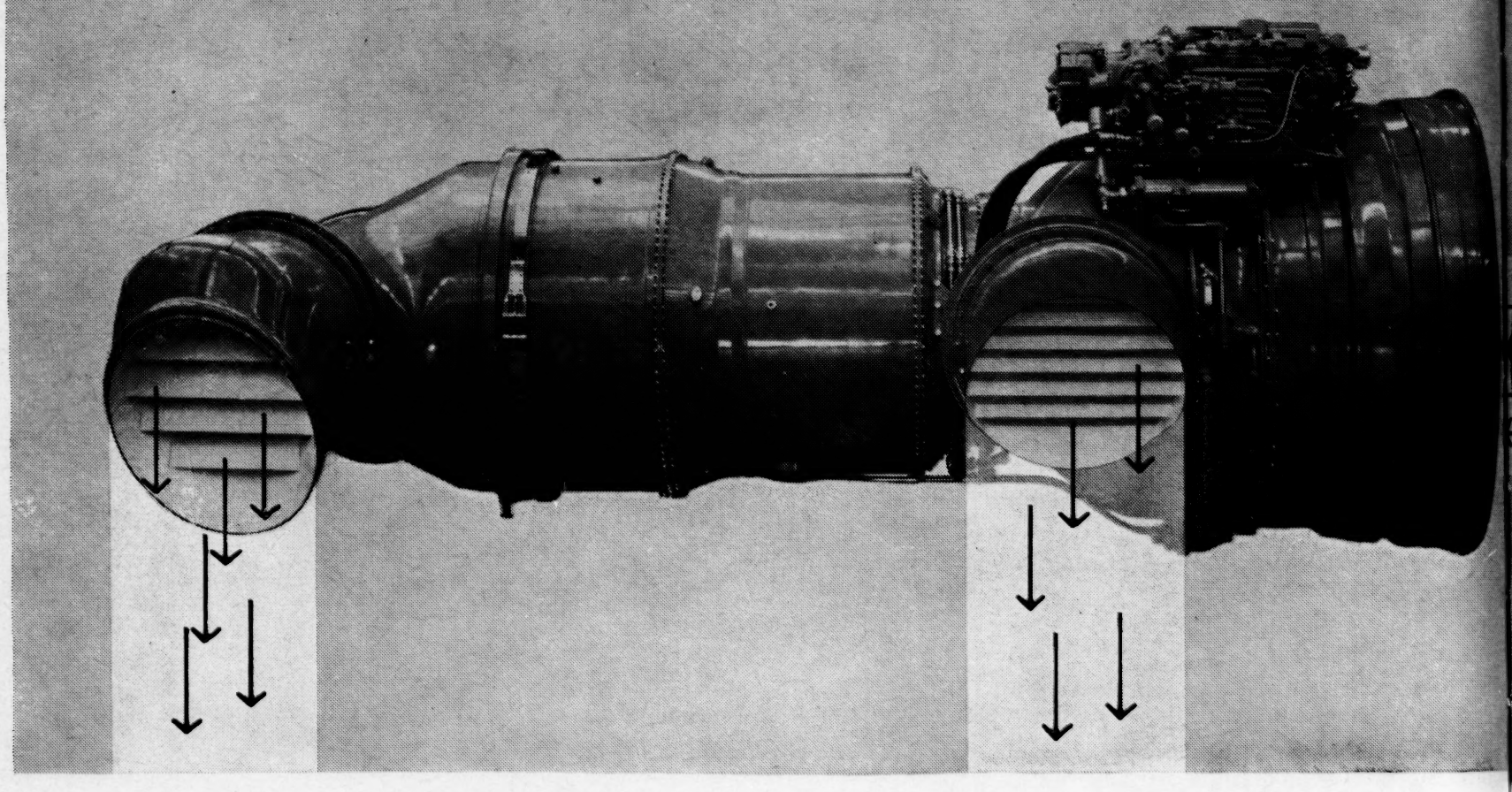
Wrenn noted that Capital's present plight suggests that the Board's past policy of making route awards to strengthen smaller carriers "may not be so sacrosanct as to require blind adherence under all conditions" in light of changing route concepts, new flight equipment and carrier obligations. Answering the objecting airlines' complaints that a combined United-Capital route system would be larger than that of American Airlines, the examiner remarked "there is nothing which indicates that it is sinister for United to replace American as the largest domestic trunkline. He added that the Board may have to permit greater expansion of airline size in the future because of the financing requirements of the jet age and problems which will arrive with the introduction of supersonic jet transports in the future.

In his over-all consideration of the merger application, Wrenn said he also considered the significant saving which would accrue to the merged airline through a consolidation of operational and administrative expenses at their 12 common stations. Estimating the savings at $4.8 million a year on the basis of 1959 costs, the examiner noted "these are public benefits which favor approval in the balancing process of determining the probable net effect of the proposed merger upon the public interest."

While recognizing that a combined United-Capital route system might divert some traffic from the objecting airlines, Wrenn questioned the "apprehension" of the carriers and termed their estimates of probable traffic and revenue losses "exaggerated." He said diversion would primarily be a matter of the merged company regaining traffic lost by Capital because of its serious financial problems.

LIFT and THRUST fr

THE REVOLUTIONARY B



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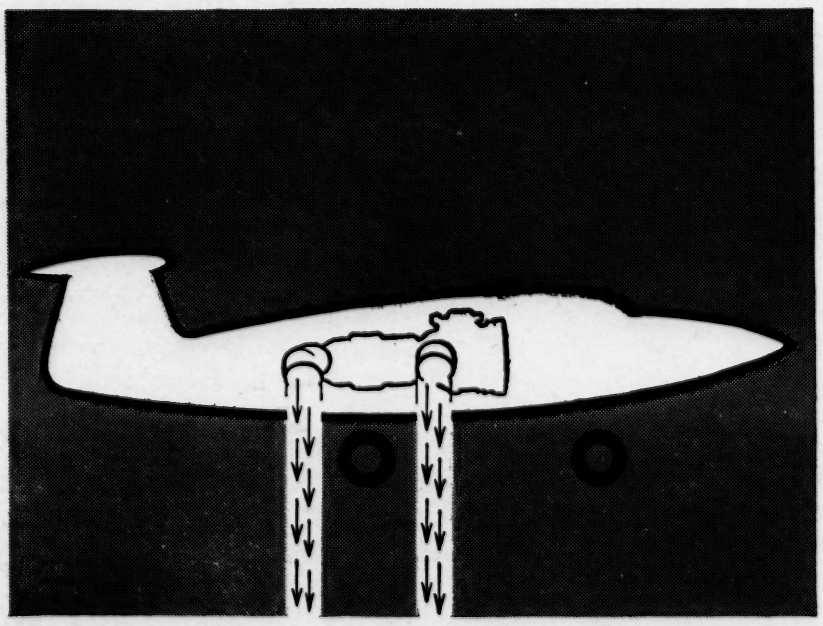

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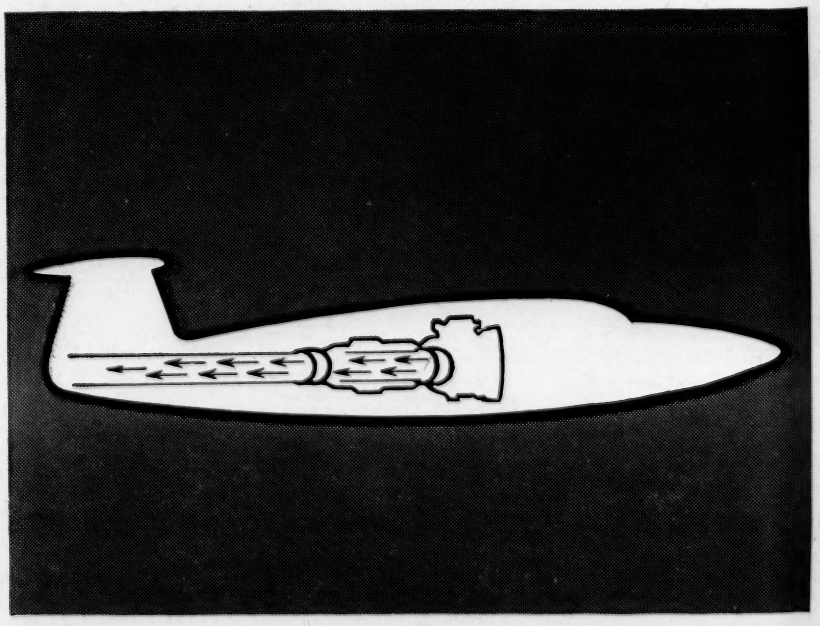

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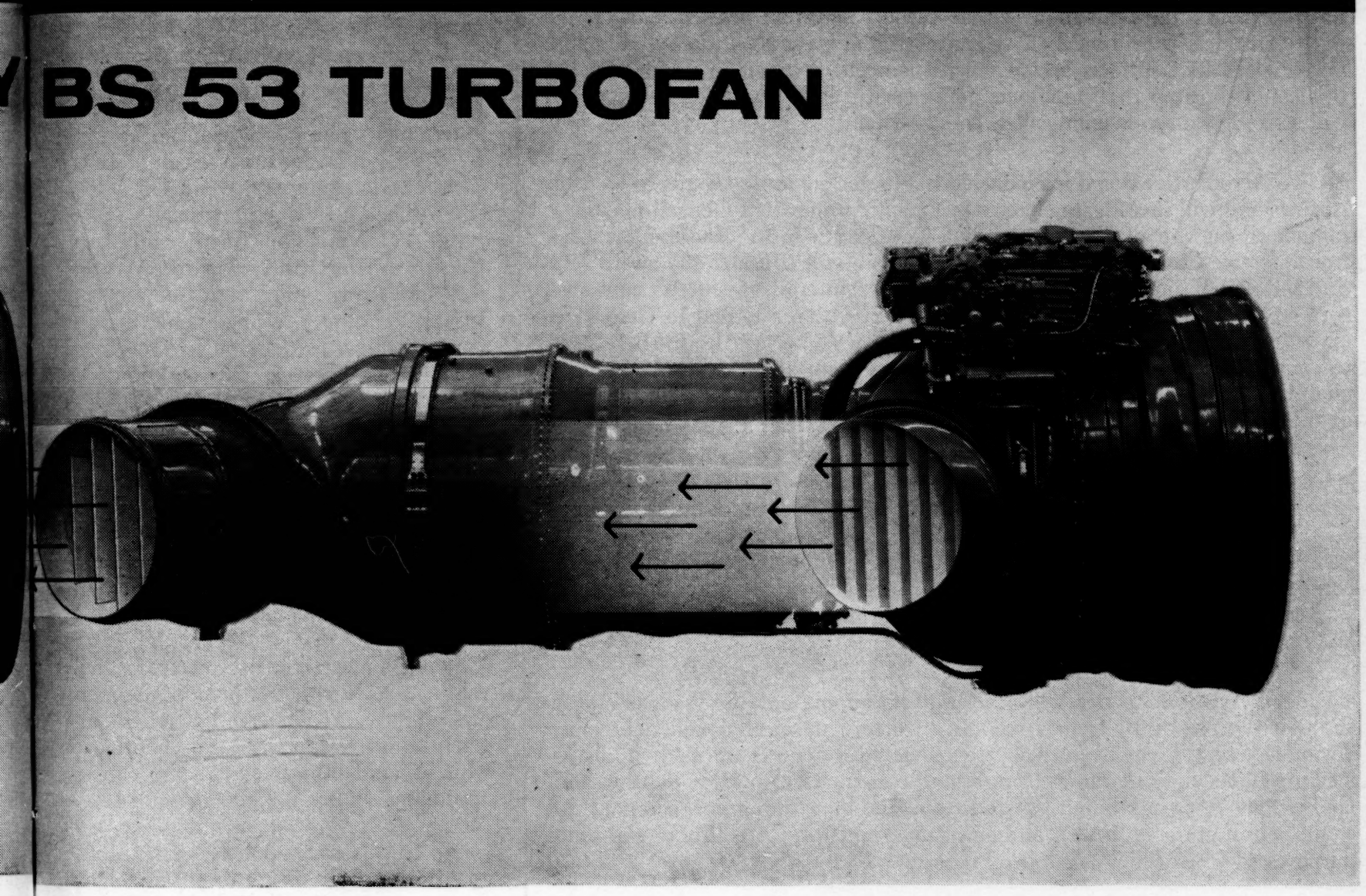

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AIRLINE OBSERVER

► Pilot-flight engineer feud may reach its climax this year over the issue of training and duty requirements for third pilots on turbojet transports. Flight Engineers International Assn. expects to complete negotiations with American, Eastern, Trans World, Pan American, National and Western on wage issues, but fears many of the carriers may sign new Air Line Pilots Assn. contracts providing flight engineer training for the third pilot before any final FEIA contracts are signed. Engineers' spokesmen point out that this could threaten their members' job security, and they indicate the union will strike any airline signing such an agreement.

► Civil Aeronautics Board is reconsidering its recent route awards to Central Airlines and will investigate charges by Ozark Airlines that Central may have influenced the vote of Vice Chairman Chan Gurney in the Kansas-Oklahoma Local Service Case. Most of the reopened case will consider the award of a St. Louis-Tulsa route to Central, which, Ozark contends, it is better equipped to serve and which the airline claims may have been awarded to Central as an indirect result of hospitality tendered Gurney. Earlier the CAB refused to accept Gurney's voluntary disqualification from the case, but the vice chairman has demanded that it be accepted to avoid any possible criticism of the Board.

► Use of television cameras as an aid to precision approach control is being urged by General Precision, Inc., for low-visibility approaches. Camera would be mounted on a retractable 100 ft. pole, aimed directly down the glide path at the runway to broadcast remotely a pilot's-eye view of approach conditions. The picture would show the controller actual approach and runway conditions. The company says this information is needed to pinpoint landing minimums for approaching aircraft.

► Federal Aviation Agency will accelerate its airport data program this year through the use of 18 facility records engineers at selected field locations. Twice a year the engineers will submit detailed reports on such items as location of the airport, runway length and construction, runway lighting and landing aids. Information is needed in the preparation of aeronautical charts, publication of FAA's airman's guide and for FAA airport planning purposes.

► Tan Son Nhut Airport in Saigon, Viet Nam, will be expanded to include a heavy duty jet runway this year under a loan granted by the International Cooperation Administration. E. V. Lane Corp. has a construction contract under which the agency will provide approximately 80% of the runway's total $4.1 million cost, with the balance financed by the government of Viet Nam.

► Pan American World Airways has established an international marketing advisory service for air cargo shippers at more than 100 trading centers abroad. Scope of the free service includes 26 cities in the U. S. and Canada, along with 114 cities located on the airlines' foreign system. Global distribution of information covers the latest business advice in addition to airline routings, tariffs, insurance, cargo containers and other subjects of interest to shippers.

► Federal government has issued an order forbidding all employes from listing the cost of flight insurance on their expense accounts. Noting a sharp increase in the volume of requests to list this item as a reimbursable expense, the General Accounting Office has issued a directive rejecting them on the ground that flight insurance is a personal expense which should not be included in the cost of official travel.

► Eastern Air Lines is now accepting young widows and divorcees without children for stewardess training. Carrier expects to canvas 115 cities in the U. S., Canada, Mexico and Puerto Rico during the next six weeks, in a drive to recruit 118 female flight attendants.

SHORTLINES

► **Aerovias Sud Americana** has asked the Civil Aeronautics Board for permission to operate transatlantic passenger charter flights to and from the U. S. The all-cargo carrier presently is certificated to operate between the U. S. and points in Central and South America and the Caribbean area.

► **Capital Airlines** has been authorized by the Civil Aeronautics Board to suspend service temporarily at Erie, Pa., and Wheeling, Morgantown and Clarksburg, W. Va. The Board said Lake Central Airlines' intention to serve the four cities was sufficient reason for the suspension order. The action arose from the Board's decision in the Great Lakes Local Service Investigation.

► **Eastern Air Lines'** petition to investigate Capital Airlines' reduced air-bus fares between Pittsburgh and Miami has been denied by the Civil Aeronautics Board. The Board said the low fares are new and untried, and they are in line with the Board's policy of encouraging promotional fares.

► **Flying Tiger Line** has received Civil Aeronautics Board permission to operate Military Air Transport Service contracts during January and February, which would bring the all-cargo carrier approximately $1,882,200 in total revenues. Services to be operated are: 34 round trips between Travis AFB, Calif., and Tachikawa Air Base, Japan; eight one-way trips from Travis AFB to Tachikawa Air Base; five one-way trips from Travis AFB to Kadena Air Base, Okinawa; five one-way trips from Travis AFB to Hickam AFB, Hawaii, and five one-way trips from Travis AFB to Clark Air Base, the Philippines.

► **Northeast Airlines** is scheduled to begin daily Montreal-Boston-Miami Convair 880 turbojet service tomorrow, a routing the carrier says is faster than flights directed through New York. On Jan. 15, Northeast is scheduling daily Boston-New York-Miami 880 flights until Jan. 31, when jet schedules will again be revised.

► **United States Overseas Airlines,** a supplemental air carrier, has received permission from the Civil Aeronautics Board to operate Military Air Transport Service flights worth $492,972 during January and February. The airline will fly 14 round-trip flights between Travis AFB, Calif., and Agana NAS, Guam, three one-way flights from Travis AFB to Agana NAS and one one-way flight from Hickam AFB, Hawaii, to Travis.

In a space vacuum, 13 thermocouple probes monitor temperatures and gradients in modules and across multiple thermal interfaces between dissipative components, mounting plates, satellite skin, and a water-cooled heat sink.

WAY OUT... AND COOL... are the electronic modules developed by Bendix Systems Division for satellite-borne communications systems. Through the use of beryllia, which is unique as an electrical insulator and thermal conductor, Bendix engineers have devised the most efficient configurations for transferring heat to the space environment. Such developments result from the team efforts of specialists in communications, microwaves, heat transfer, packaging, and advanced anti-jam techniques. Positions on this team are open to better scientists and engineers.

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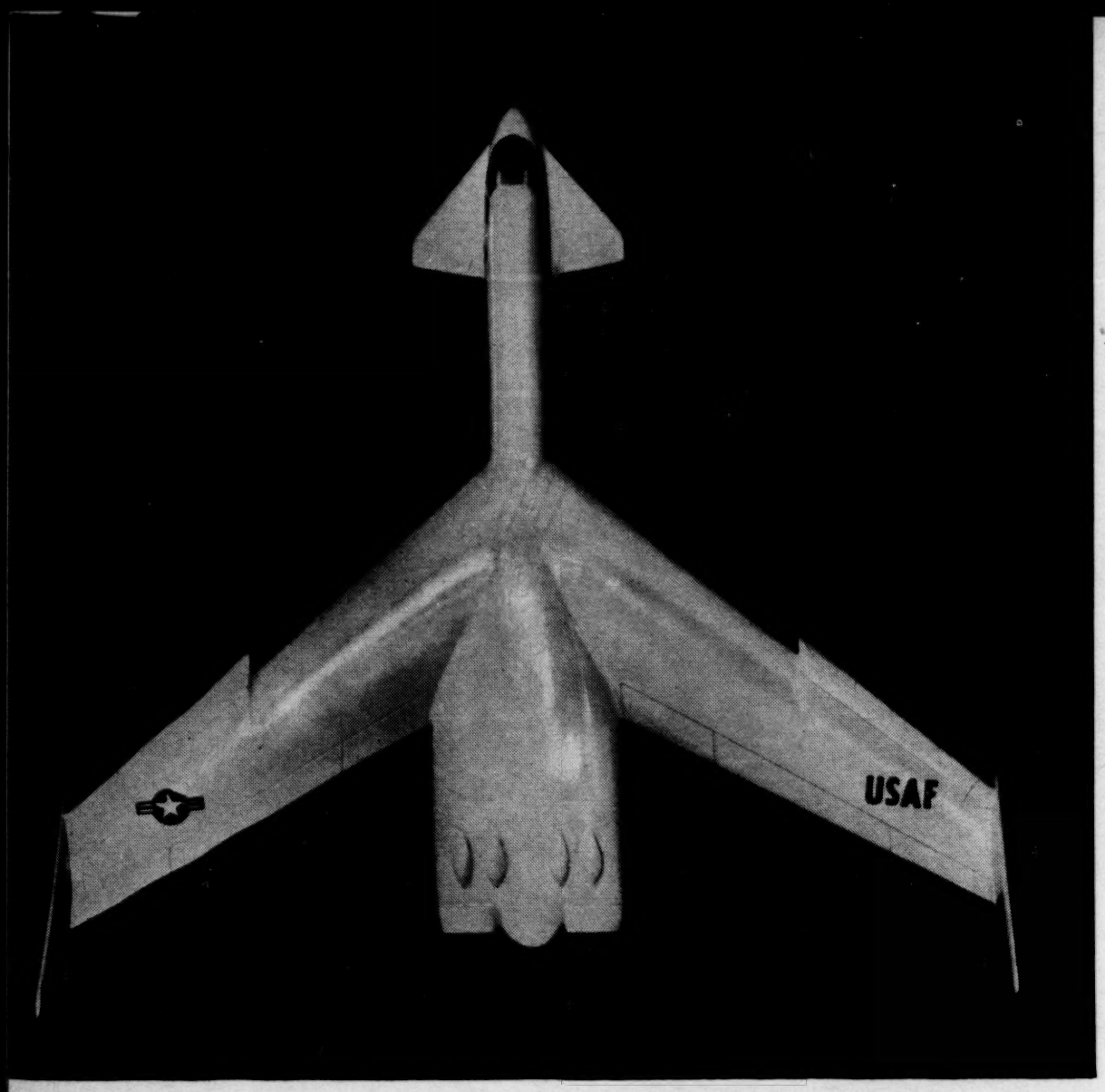
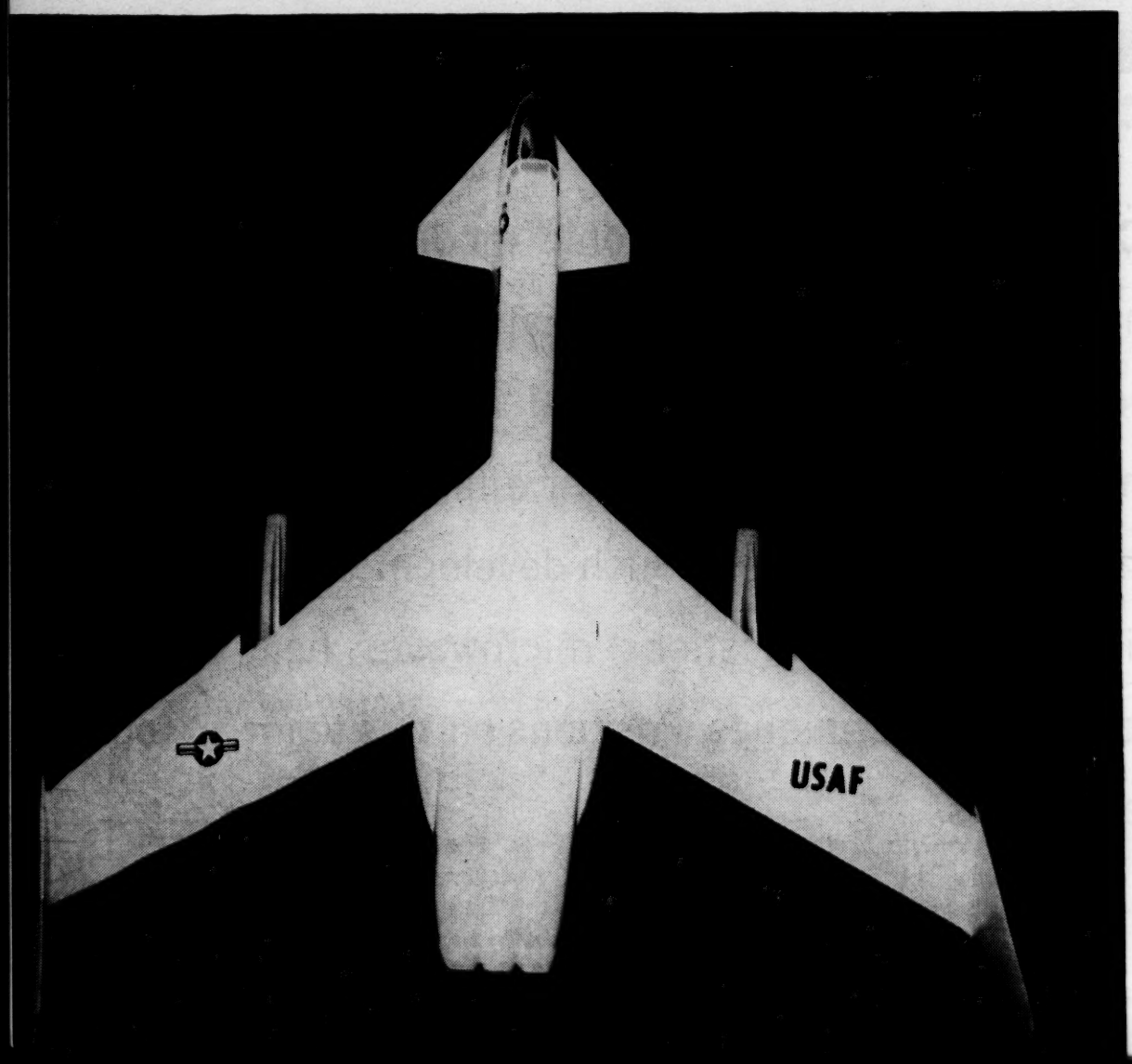


EXPERIMENTAL nuclear-powered-aircraft now scheduled to fly in 1965 is the Convair NX-2. Entire aft end is devoted to the nuclear engine installations in two configurations, one for each engine type now being developed. Configuration above carries four P&W indirect cycle nuclear engines which are modified J58 turbojets. The subsonic configuration below is to be powered by three GE X-211 direct cycle nuclear turbojets which will provide the necessary power for all flight conditions except takeoff. For this, and to provide a power margin against the loss of an engine during takeoff, two chemical fueled turbojets, P&W J75s, will be carried in wing pods.



Special Report:

NX-2 Design

This is the fourth of a series of articles on the various applications of nuclear power to aircraft and space vehicles.

Washington—Aerodynamic configuration of the Convair NX-2 testbed, the first U. S. aircraft planned to fly under nuclear power, illustrates the approaches designers must take to cope with hazards of nuclear engines and still keep radiation shield weight to a minimum.

Minimum shield weight was the primary consideration in laying out the NX-2, and this probably will be the priority design goal for all future nuclear-powered aircraft. Airframe designers can use engine location, structural layout and other features to keep the special problems of nuclear flight to a minimum in developing this new type of aircraft.

Some of the problems faced by NX-2 designers, and their solutions:

• **Engines were placed** in the fuselage rather than in pods under the wing to reduce the side radiation on the nose. This significantly lowered the weight of the crew compartment shield and reduced the length of the fuselage. The fuselage position also allowed major structural components to shadow-shield the rear of the crew compartment.

• **Canard configuration** was chosen because it kept the crew compartment and the reactors a maximum distance apart. Canard arrangement allows the center of lift and the center of gravity to be placed near the aft end of the fuselage by eliminating the conventional empennage. Almost the complete fuselage length is used to separate the crew and the reactor.

• **Lift/drag ratio** was improved by the canard configuration because the trim lift on the nose-mounted horizontal control surface is up, rather than down as it is in the conventional arrangement with the control surfaces on the aft end of the fuselage behind the center of gravity. Vertical stabilizing surfaces placed on the wing tips also improved the lift/drag ratio by acting as end plates, increasing the wing's effective aspect ratio and cutting down its drag due to lift. Lift/drag ratio will be of major importance on nuclear aircraft, especially the first one.

Power required depends directly on aerodynamic efficiency as represented by the lift/drag relationship. The reactor power and temperature required can be lowered as the lift/drag ratio is improved. For a given reactor power, any

Reflects Approaches to Shielding Problems

improvement in lift/drag ratio will increase the liveliness of the nuclear aircraft.

• **Installation and removal** of the entire engine-reactor-shield package is facilitated by the canard design of the NX-2. Both direct and indirect cycle nuclear engine systems can be isolated behind the wing and all of the structure in that area can be devoted simply to supporting the engines. Complexity of nuclear powerplants and the general difficulty of servicing and replacing them probably will make such isolated installations attractive for operational as well as experimental aircraft. On the Convair testbed, it also has the advantage of allowing two engine systems of different sizes and weights to be handled without major modification of the basic airframe.

• **Structural heating** and high acoustical loads will be problems with all nuclear engines because of reactor and shield heat and the fact that all of the engines under discussion will move large quantities of air and will be noisy. Elimination of the conventional empennage by the canard layout significantly reduces the areas effected by acoustical loads and structural heating.

• **Aileron control power** required on nuclear aircraft is reduced to a major degree by placing the powerplants in the fuselage. The aircraft's moment of inertia about the roll axis for this arrangement is well below that for wing-mounted engines, and much smaller lateral control surfaces can be used.

Nuclear aircraft of all types will have a major airframe design advantage over chemically fueled airplanes because they will have no range specification to meet and will carry very little if any chemical fuel. The only possibility is a small chemical fuel load to assist in landing and takeoff or to provide a short, high-speed dash capability. Elimination of the range requirement generally lowers the sensitivity of the nuclear aircraft to added weight as long as its volume is placed inside the aircraft and does not increase the aerodynamic drag coefficient.

On chemically fueled aircraft, adding a pound of dead weight means adding several more pounds of structure powerplant and fuel, with fuel the largest item. Estimates of the total growth in gross weight required to add one pound of equipment or payload usually run from 10 to 20 lb. on the chemical aircraft. It is believed that this figure will be less than 5 lb. for the nuclear aircraft, where only the structural and powerplant weights need to be considered.

Absence of chemical fuel on the nuclear aircraft will reduce the large center of gravity travel associated with big, widely distributed disposable loads. As the center of gravity travel is shortened, the range of trim moments is reduced and horizontal tail area can be decreased.

Balancing also is expected to be an easier task for the nuclear aircraft. Transfer of small percentages of the total shield weight between the front of the reactor and the rear of the crew compartment can be a powerful balancing tool because of their separation distance. Small weight transfers of this type will have little effect if any on the nuclear dose experienced by members of the crew.

Weight may become a problem with the Convair NX-2, primarily because it is the first of its type and it will have to accommodate one of two untried engine systems—and possibly both of them. The direct and indirect cycle engines will have different weights and different thrust-to-weight ratios, so the NX-2 airframe cannot be an optimum size and weight for both of them.

Since neither of the nuclear engine development programs has entered the test phase on a complete flight weight system, the NX-2 design has had to allow for a substantial variation in final powerplant weight. The airframe gross weight selected was a compromise weight which could be handled by four Pratt & Whitney indirect cycle engines or three General Electric direct cycle engines plus two J75 booster turbojets delivering a total of about 30,000-lb. thrust at takeoff.

Tested Disadvantages

Disadvantages which must be accepted with the test aircraft layout, but which are heavily outweighed by its advantages, include:

• **Center of gravity** area tends to be crowded when the great bulk of the nuclear engine is placed in the fuselage. The disposable load, the reactor, engines and landing gear and other heavy equipment must all be located near the center of gravity. Placing either the engines or the disposable load in pods relieves this situation. It is not as great a problem on testbed aircraft as it would be on an attack vehicle with a large disposable load.

• **Tendency to dutch roll,** because directional stability is low compared with lateral stability. Effective tail length for the vertical surfaces on the wing tips is small compared with what it would be if the aircraft had a conventional empennage. The short tail length reduces the restoring moment available when the aircraft yaws in flight. It is possible to compensate for this by using very large vertical surfaces or automatic stabilization.

• **Increase in structural weight** because the engines and reactor system are concentrated in the fuselage near the center of gravity. Wing structural weight can be lowered by properly distributing non-structural weight along the span. On chemically fueled aircraft, large quantities of fuel and the engines can serve this purpose. During flight, the maximum bending load at the wing root is reduced because the lift force is relieved by the dead weight in the wings.

Engine-Airframe Matching

The problem of matching a nuclear engine to an airframe is much more involved than it is for a chemically fueled engine. This is true even if the radiation effects on the aircraft structure and systems are ignored and the shielding bulk is considered only from the weight standpoint.

Design of a chemical turbojet is initiated by selecting the compressor pressure ratio. This pressure ratio is determined by the efficiency which can be expected from all of the engine's components including the air inlet duct, by the turbine inlet temperature and the operating altitude. The compressor pressure ratio will vary somewhat, depending on whether fuel consumption or maximum thrust is considered most important. Matching the engine to the airframe is primarily a matter of making sure that the aircraft's inlet duct will provide the required mass flow of air at the necessary ram pressure under all flight conditions.

As a general rule, at supersonic speeds when the ram pressure in the inlet duct is high, the best engine efficiency is realized when the compressor ratio is low so that the total pressure rise stays near the optimum value. Conversely, at subsonic speeds the compressor ratio should be high to compensate for the

low ram pressure rise in the inlet to keep the engine running well.

The best chemical engine and airframe combinations have been achieved when the aircraft and engines were designed specifically for each other and matched properly in the early design stages. It has been possible, however, to design engines for general use and through proper inlet design adapt them effectively to several different airframes for use at both subsonic and supersonic speeds.

The task of combining a nuclear engine and airframe is much more difficult because there are more variables which affect the final solution. Ideal compressor pressure ratio is affected not only by component efficiencies, optimum altitude and turbine inlet temperature, but it is also directly influenced by changes in shield weight, maximum reactor wall temperature, and the free-flow area ratio of the heat source that corresponds to the combustion chamber on chemical engines.

In general, the performance of a nuclear turbojet engine is highly sensitive to its weight and the efficiencies of its separate components. Apparently this will not be of major importance on the NX-2 testbed. This aircraft is described by defense as having a high payload, and this payload can be exchanged for improved performance if the current engine developments are not as successful as predicted.

On tactical aircraft, such a margin will not be available and these engine design factors will be critical. Briefly the importance of these factors and the part each can play in improving the nuclear engine and aircraft performance are:

• **Reactor wall temperature.** This is the most direct key to giving the nuclear engine better performance. As soon as reactor materials are developed which can operate over long periods at 2,300F or better, there will be few valid arguments against nuclear powerplants. This reactor wall temperature will provide a turbine inlet temperature of 1,850F or better, which is about the operating temperature of chemically fueled turbojets, and it will significantly improve the thrust-to-weight ratio of the nuclear engine. Speed, altitude performance and load-carrying ability of the nuclear aircraft would be materially improved by this increase in engine operating temperature. The minimum size of an efficient nuclear aircraft also could be reduced 25% or more.

The increase in reactor temperature necessary to bring about the clear superiority of nuclear powered aircraft is about 300F—today's test reactors are good to around 2,000F. A large number of basic and applied research groups in the U. S. are working on the problem of finding better high temperature materials for reactors. Although good progress is reported, most experts feel that a major improvement is at least several years away. Improvements in aerodynamics and turbine engine technology probably will make the supersonic, high altitude nuclear aircraft feasible before the improved materials are developed. If this occurs, the improved materials, when available, would further increase the desirability of nuclear-powered strategic attack systems.

• **Free-flow area ratio** of the heat source. In the direct cycle arrangement, when the engine air flows directly through the cylindrical reactor, the free-flow area ratio involves the forward face of the reactor. It is the ratio of the area of the air passages in the forward face of the reactor to the total area of the forward face. Engine thrust and altitude performance are increased as the free-flow area ratio is increased and the reactor is opened up to let more air through.

Free-Flow Area

The free-flow area ratio is a very important design factor for the reactor as well as a key factor in the engine design. Reactor design becomes more difficult and the amount of fissionable fuel required increases as the air passages are enlarged and the free-flow area ratio increased. So for the direct cycle engine, the reactor and engine design objectives conflict and a compromise must be made. Usually the compromise must be in favor of the reactor, with the engine altitude performance restricted.

On indirect cycle engines, the free-flow area ratio pertains to the radiator or heat exchanger, which is the heat source in the turbojet. This heat source can be designed to achieve the most efficient heat transfer performance without the complication of considering reactor design at the same time. As a result, the indirect cycle engine is more flexible as far as free-flow area ratio is concerned, and it probably will be a better high altitude engine.

• **Shield weight.** Shield weight is a function of reactor diameter and reactor power, and it has a great effect on the minimum size of the nuclear-powered aircraft. For the direct cycle engine, there is an optimum reactor diameter for a given reactor power, free-flow area ratio and shield weight which will give the engine a maximum thrust-to-weight ratio. Generally speaking, this thrust-to-weight ratio is tied closely to the design altitude, which is the maximum altitude if the aircraft weight is kept constant. If it is necessary to raise the design altitude and it is impossible for nuclear reasons to increase the free-flow area ratio, then the reactor diameter and shield weight must be increased. The minimum aircraft weight for a given payload capability then increases rapidly.

Aircraft using indirect cycle engines will not be nearly as sensitive to shield weight. The indirect cycle reactor is much smaller and shield weight does not increase rapidly if reactor power is increased to operate a larger engine radiator for greater thrust or better altitude performance.

• **Component efficiencies.** Nuclear engines of both the indirect and direct cycle designs will be more sensitive to the efficiencies of their turbines, compressor sections and other components than chemically-fueled engines. This is because they will have to operate at higher compressor pressure ratios—probably about 20-1, compared with about 12-1 for J79 class turbojets. High compression ratio is needed on each type of nuclear engine to overcome the pressure loss of two units which are not needed on the chemically fueled turbojet. On the direct cycle engine, these high drag units are the reactor and the shields placed in front of and behind the reactor. These shields prevent radiation from streaming directly out of the core, and the air ducts leading into and out of the engine must bend around them. On the indirect cycle engine, the radiator which heats the engine air has a high drag and there is a large pressure loss in bleeding off compressor air to operate the pumps in the liquid metal heat transfer system.

• **Altitude.** The altitude specification has a greater effect on the design of an aircraft using direct cycle engines than one using indirect cycle powerplants, because the direct cycle reactor must be a nuclear heat source and a radiator simultaneously. Altitude performance on both types of nuclear engine is very sensitive to compressor design. Large chord compressor blades and high compression ratios will increase the operational altitude of both of these engines just as they will on chemical turbojets, although the indirect cycle engine and chemical turbojets can derive the most benefit.

• **Turbine inlet temperatures.** It would be possible with currently planned direct cycle nuclear engines to make the turbine inlet temperature equal to or higher than the temperature for chemically fueled turbojets. This is possible because the reactor wall temperatures are higher than the turbine inlet temperatures on the chemical engines. It is not practical, however, because the reactors would have to be lengthened considerably to give the engine air more time to be heated. Pressure losses would rise rapidly with the increased length so that engine thrust would be drastically reduced.

For a given set of reactor air inlet conditions and reactor wall tempera ture, there is a definite length-to-diam-

eter ratio for the reactor air passages which will produce a maximum engine thrust by properly balancing turbine inlet temperature with reactor pressure losses. This air passage length-to-diameter ratio is also a major factor in the nuclear design of the reactor.

On the indirect cycle engine, the pressure losses in the radiator must also be balanced properly against turbine inlet temperature to get maximum engine thrust. The goal on both types of nuclear engine is to raise turbine inlet temperature by increasing the wall temperature of the heat source or by improving heat transfer efficiency.

Materials Research Effort

Selection of the best construction materials, lubricants and fluids for a nuclear aircraft's structure and systems has been the objective of a systematic research effort funded by the ANP project since 1950. When aircraft equipment and structure were first tested in strong radiation fields, the results were extremely disappointing. Radiation from the fission process quickly altered the composition of all organic materials and radically changed their physical properties. Rubber tires became as brittle as glass, glass became fogged, lubricants and hydraulic fluids turned into a jelly-like mass and electronic equipment ceased to function. Many basic materials deteriorated much more quickly than they were supposed to according to theory.

One of the most hopeful signs concerning the feasibility of a nuclear aircraft was the fact that aluminum has a low threshold of radiation damage so that its strength is not impaired and it does not become highly radioactive when exposed to strong radiation fluxes. It could be considered a good construction material that would last the life of the nuclear aircraft for most structural applications.

Difficulties Overcome

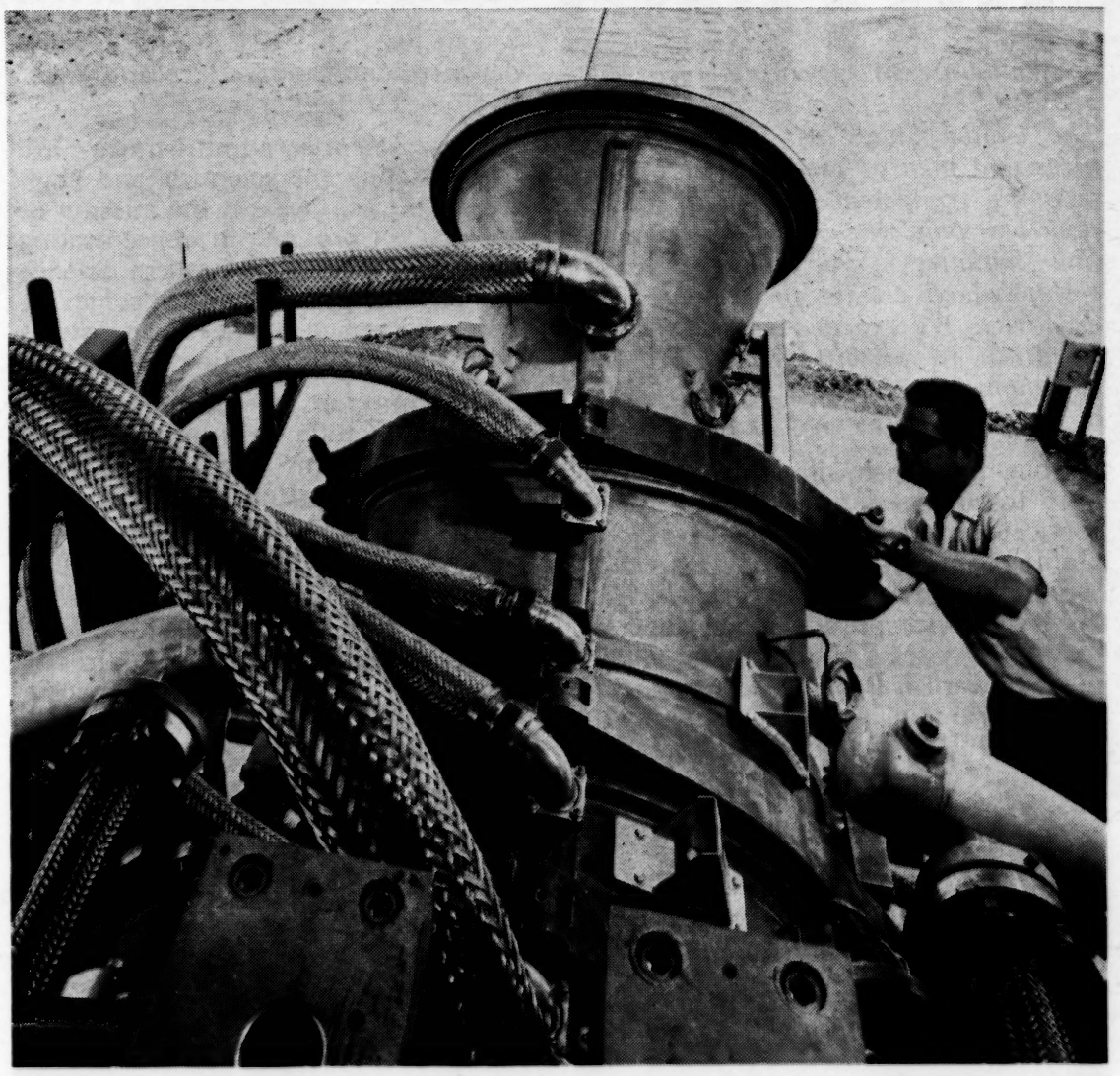
Major radiation difficulties with aircraft materials and systems have been overcome through the work of a large number of industrial firms, universities, nonprofit groups and government agencies.

It has been considered possible for three years or more to build the systems needed for the first nuclear aircraft.

Current status of the development work is shown in the chart (AW Jan. 2, p. 51). Useful life of the radiation sensitive components in nine major aircraft systems are shown there. Useful life is defined as the operating time before any deterioration in physical properties or operating efficiency sets in. All of the components could be used in a test aircraft, and most are approaching or have bettered the goal of 1,000 operating hours between overhaul. Radia-

Tory II-A Nuclear Ramjet Engine Details

Nozzle of Tory II-A below is elevated 38 deg. to prevent the radioactive exhaust air from contaminating the earth near test bunker too heavily. Project Pluto facilities in 401 Area of AEC Nevada Test Site are linked by a railroad along which an unmanned, battery-powered electric locomotive moves the flatcar carrying Tory II-A. Flexible hoses carry cooling water to nozzle. Nuclear ramjet reactor core (above) is loaded with 4-in. long tubular homogenized beryllium oxide and uranium fuel elements at University of California Lawrence Radiation Laboratory. Segmented structure of core reduces the risk of damage by thermal shock. Alloy steel tension rods at corners of hexagonal fuel element matrices hold core against the 100,000-lb. pressure of air stream.



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tion environment used to determine useful life information is equivalent to the average radiation level on a subsonic attack aircraft using divided shielding.

Contract Work Grows

Volume of contracts for radiation effects studies has grown each year, and more work in this area is being done today than ever before. The services, the AEC and industry are all contributing to the financial support of this effort. The useful life of most of the systems in the chart (AW Jan. 2, p. 51) grows each year.

In 1957, the Air Force established a Radiation Effects Information Center (REIC) at Battelle Memorial Institute. This center is currently receiving information from more than 125 research projects.

Major contributions in the development of systems for the nuclear environment have included:

- **Radiation resistant tires,** seals and O rings by B. F. Goodrich Co.
- **Communication, navigation** and identification equipment by Bendix Aviation Corp.
- **Transistors, ferrroelectric,** magnetic and silicon devices by Bell Telephone Laboratories, Inc.
- **Radiation resistant,** high temperature base fluids that can be used as lubricants, heat transfer agents and in hydraulic and power transmission systems have been developed by Shell Development Co., California Research Corp., Esso Research and Engineering Co. and Midwest Research Institute. Effective solid lubricants have also been developed by these firms.

Air Force studies have shown that the task of manning nuclear-powered aircraft effectively during flights of five days will present no major problems even though the crew compartment will have only about 140 cu. ft. of space per man.

These studies also indicated that for flights longer than 120 hr. in nuclear aircraft or in space vehicles, the volume available for the crew would be a critical factor.

Simulator Data

Most important information in the Air Force experiments came from a simulator built by Lockheed's Georgia Division. This simulator had a total internal volume of 710 cu. ft. with work areas for five men and an off-duty area for resting. The five crew stations: pilot, copilot, bombardier-navigator, flight engineer and defense director.

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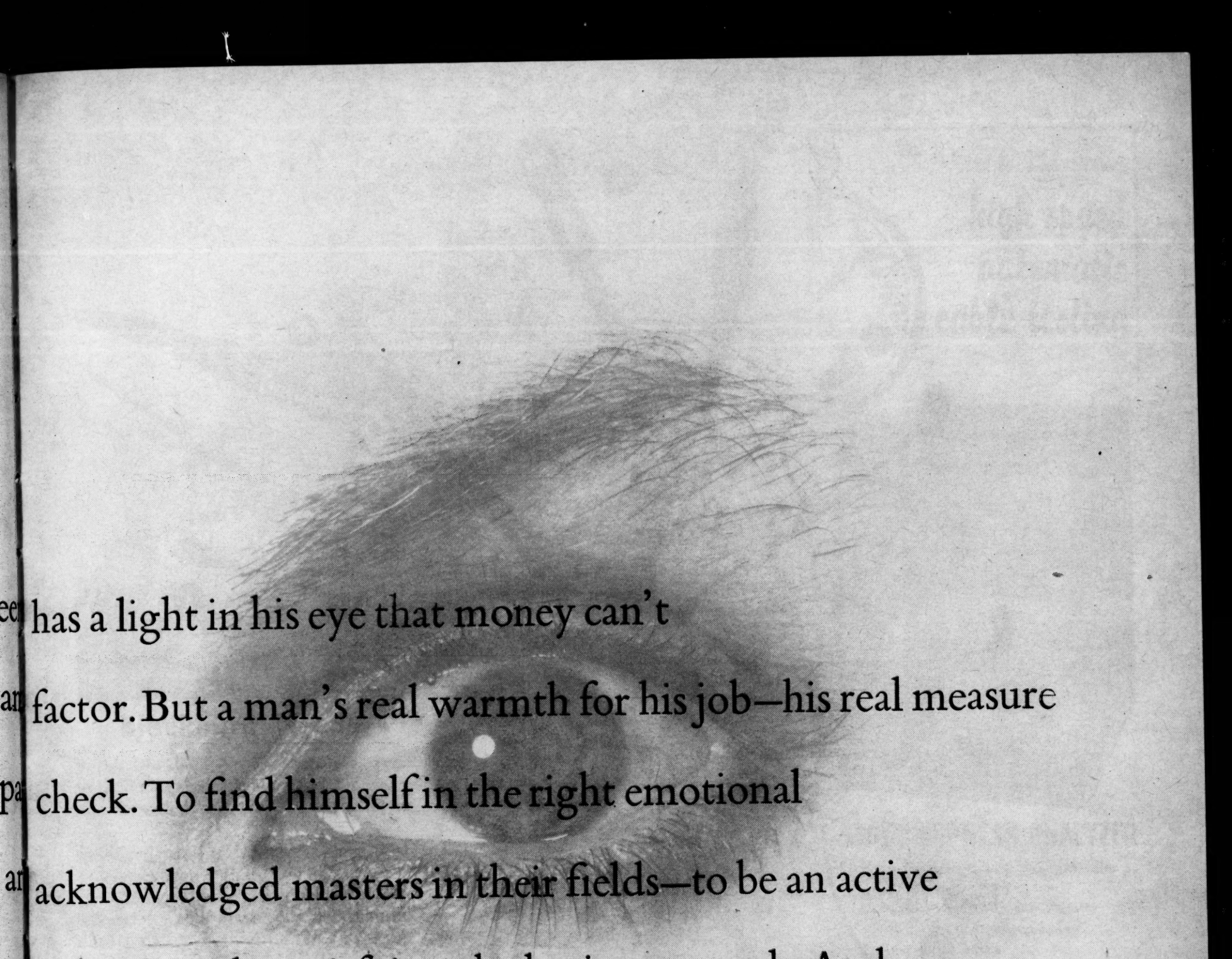

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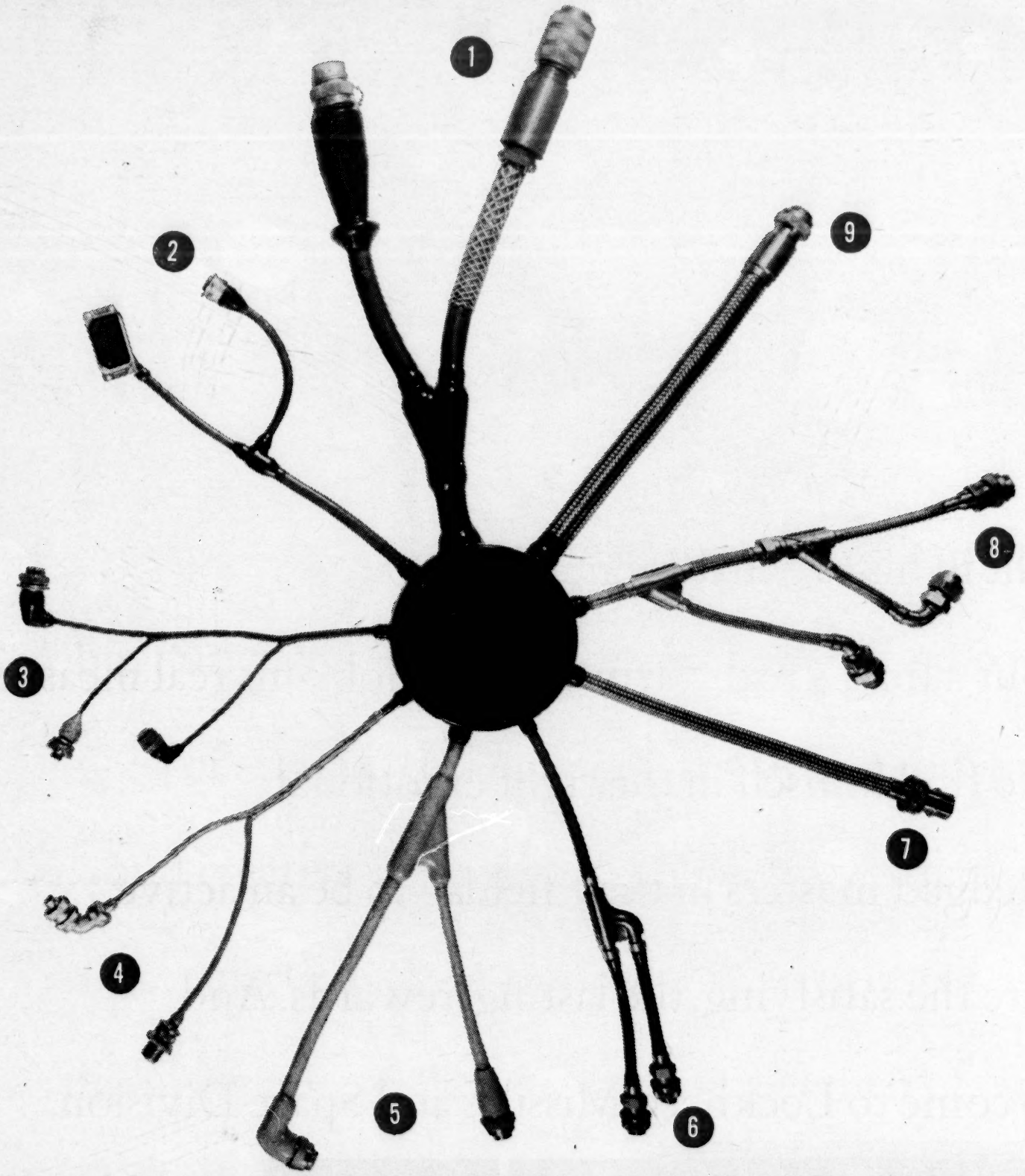

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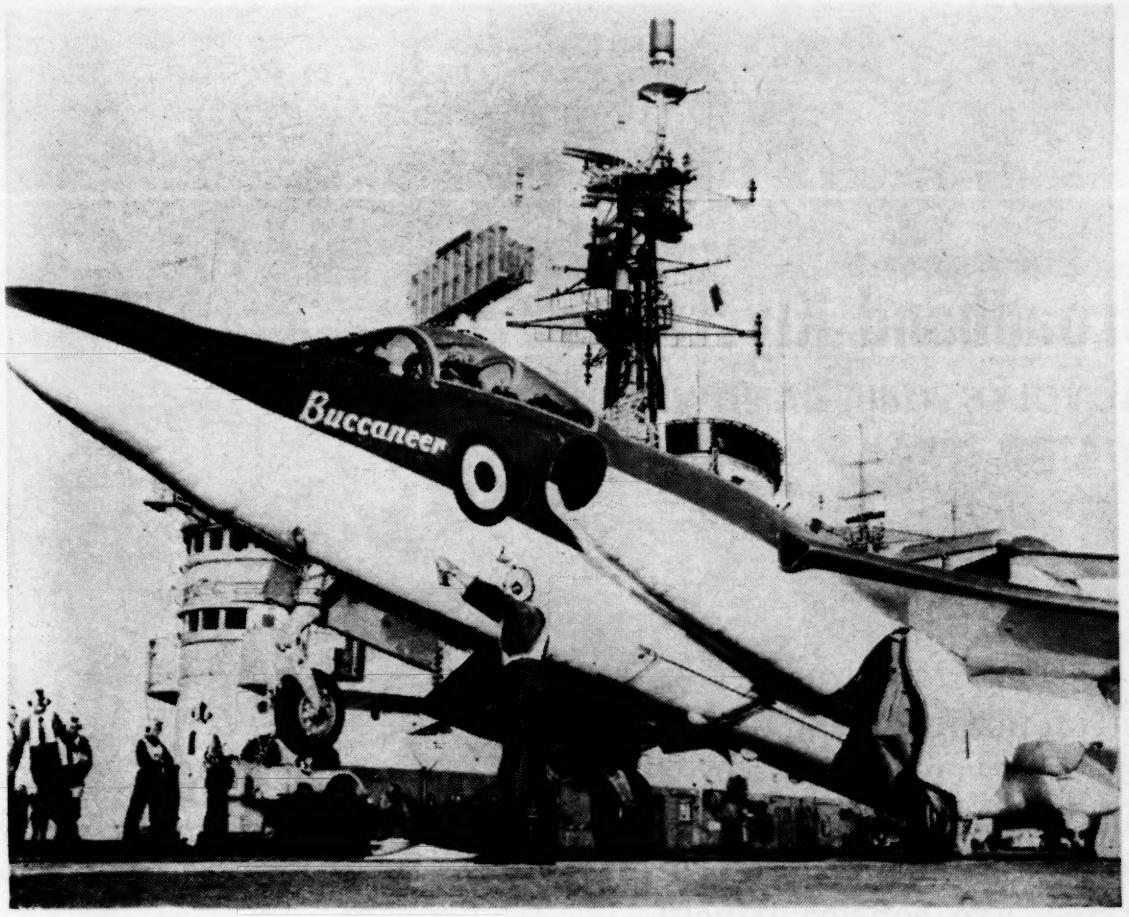

Blackburn NA.39 Prepared for Catapulting

British Blackburn NA.39 Buccaneer assumes unusual attitude on catapult of H.M.S. Ark Royal during recent landing trials. Low-level attack aircraft rests on its main gear and tail snubber with nose gear several feet off deck as tension is taken up on catapult bridle.

measured during the complete test.

It is expected that only three of the crew stations, pilot, flight engineer and navigator, will have to be manned during the entire flight. The remaining two will be manned only 10% of the time, 5% of which is estimated to be in combat and the other 5% for take-off, landing and emergencies. About 90% of the nuclear flight time will be constant-power cruise.

Crew members will be trained to fill all of the flight assignments so the work load can be equalized during cruise.

Simulated Flights

Three simulated nuclear aircraft flights of five days have been conducted with this equipment. One crew was considered to be highly motivated, highly familiar with the ANP project and highly desirous of seeing it successful. One crew consisted of men with long flight experience and highly competent at the time of the test, but with little knowledge of the ANP program and without a great deal of concern about its future. The last crew was selected at random from Air Force flying personnel without regard for their background or current flight proficiency. To generate a solid antagonism against the test, this crew was notified late one Friday afternoon that they had to cancel their plans for the next week and enter the simulator immediately.

All of the crews making the simulated nuclear flights showed themselves competent to handle their mechanical duties during the entire flight and to remain alert and vigilant during the long off-duty periods of potential boredom.

The first two crews made higher scores on the various mechanical tests they were given during their duty periods.

Four-Man Crew

Current plans call for a crew of four in the Convair NX-2 during long range nuclear-powered flights. For the first nuclear flights of comparatively short duration, a two-man crew will be used and test instrumentation will fill the rest of the crew compartment.

Escape system on the NX-2 will use an upward ejection seat. A section of the crew shield will be blown out above each man automatically once the ejection sequence is initiated. Only other unique feature of the nuclear aircraft escape system probably will be an automatic provision to scram the reactor and stop its power production before any of the crew can be ejected. It only takes a few milliseconds to accomplish this and stop the main radiation. An unshielded crewman will be safe during a brief ejection seat ride back over the aircraft if only the residual radiation from the structure is present.

Escape from a supersonic nuclear-aircraft will have to be in capsule similar to the B-70 escape pods. ◆◆

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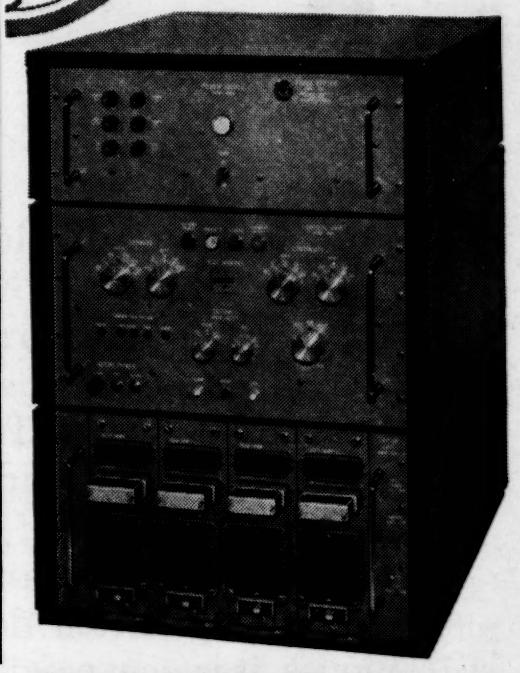

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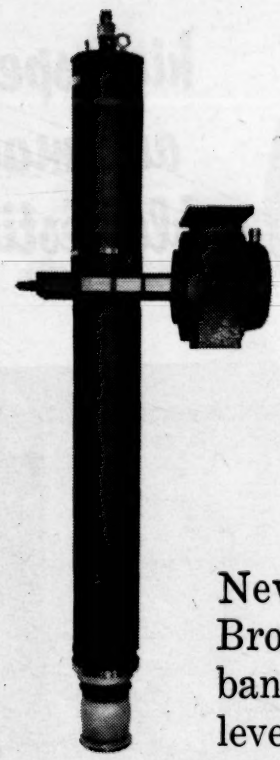

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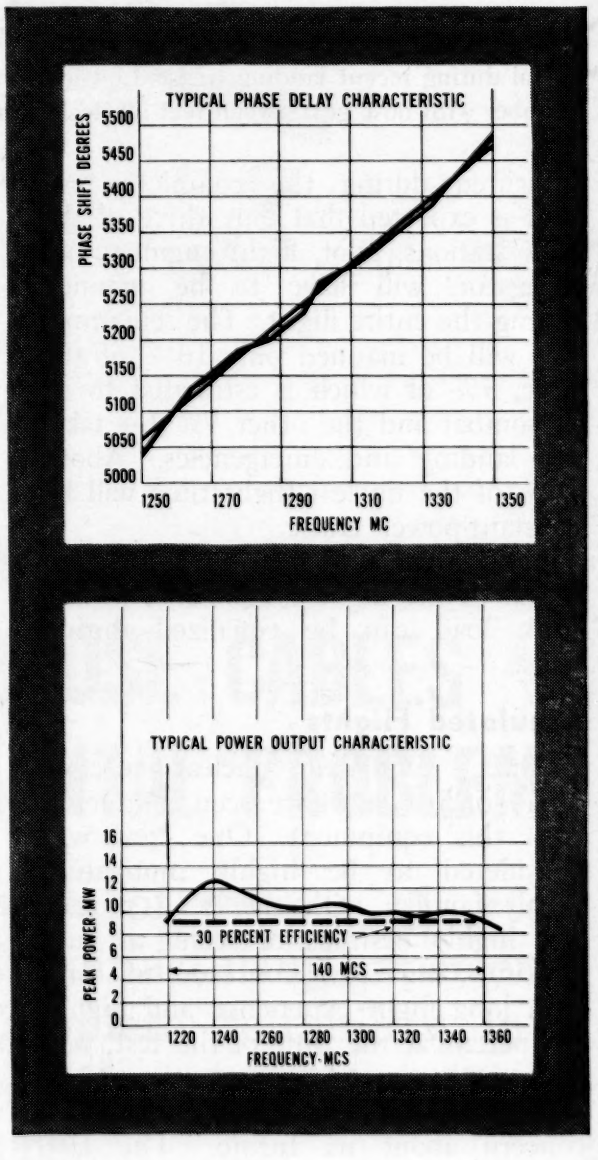

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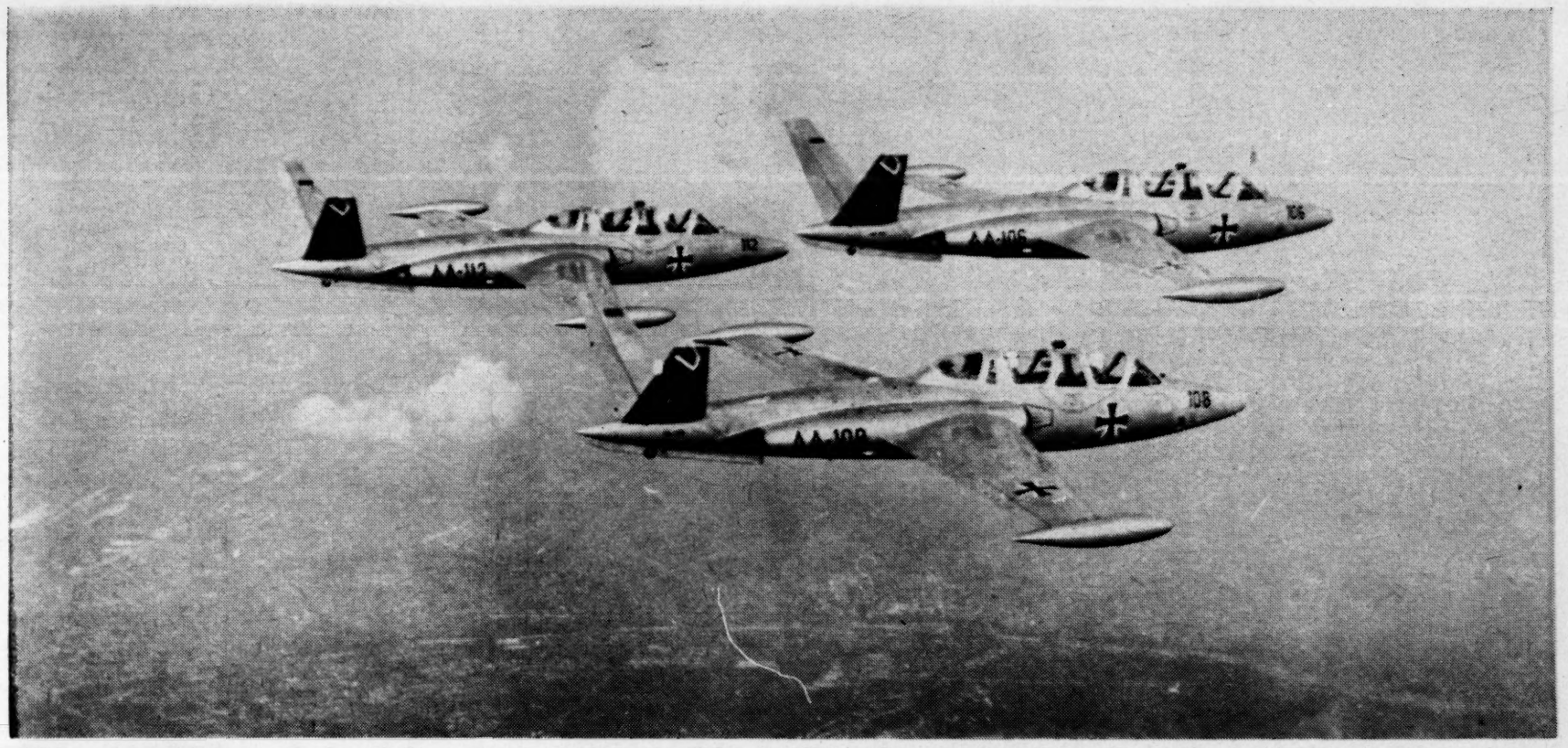

FOUGA MAGISTER is only jet of three primary trainers used by the West German air force in its rapid pilot buildup. Pilots will progress from the Fouga to the Lockheed T-33 basic trainer or, within the near future, directly to the Fiat G.91 close-support fighter.

Luftwaffe Stresses Jet Pilot Training

By Cecil Brownlow

Furstenfeldbruck—German air force training command, in its drive to meet the demands of the growing West German air force for added pilot strength, is transitioning students from three primary aircraft with widely-ranging performance onto the 600-mph. Lockheed T-33 basic jet trainer.

They are:

- **Fouga Magister,** which the Germans originally had ordered as a T-33 replacement, with a maximum speed of 435 mph.
- **Piaggio P. 149,** with a maximum speed of 192 mph.
- **North American T-6,** inherited from the U. S. Air Force and with a history preceding World War II, with a maximum speed of approximately 205 mph.

Students from all three groups are arriving at the T-33 base here, which also headquarters the Kommando der Schulen (Training Command), with the same number of flying hours on their respective primary trainers—110. And, although for many the change is a marked one, most students make it successfully through the 80-hr. flying syllabus at Furstenfeldbruck and move on to operational training units and, from there, into actual squadron service.

As usual with most air forces, however, the large majority of marginal students have been found and weeded out long before reaching the basic training stage.

Over-all Training Command washout rate from basic training through operational training averages about 60% as compared with Furstenfeldbruck's 16%.

Of the three primary aircraft now in use, T-33 instructors here generally prefer the T-6 for reasons that add up to a possibly unwanted tribute to the handling characteristics of the Fouga Magister. The Magister, they say, is "too easy" to fly and gives the student a "false sense" of jet experience (AW Dec. 5, p. 72). Among the primary difficulties experienced by Magister students transitioning onto the T-33, according to the instructors, are night and formation flying where the seemingly small reaction times between the two aircraft are significant. T-6 pilots, more impressed by the fact they are flying a jet for the first time, generally are well aware that they must master vastly different reaction times, and perform accordingly.

P.149 Trainer

The P.149, built in Germany under license by Focke-Wulf, actually was never envisioned as a primary trainer for jet pilots. It was purchased by the air force for the instruction of prospective Transport Command crews. However, transport training is now being held in abeyance awaiting the appearance of the twin-turboprop Nord Transall. Pilot commitments for the two Nord Noratlas wings of the air force have been met and, as one Furstenfeldbruck officer says:

"We have the P. 149, and we need jet pilots, so we have to use it."

German officials still plan to slowly phase out the T-6 in favor of the Magister and to raise the number of flying hours on the Fouga for each student from the present 110 to 160, at the same time cutting back requirements on the more-expensive-to-operate T-33 from 110 to 80 hr.

They also hope that student pilots slated for the Fiat G. 91 close-support fighter which will be phased in over the next few years can transition directly from the Fouga, bypassing the T-33 phase. Hours currently planned for transition onto the G. 91 at Waffenschule 50 located on Erding Air Base are 40.

Present 110 hr. flight syllabus at Furstenfeldbruck breaks down into 30 hr. transition, 27 by day and 3 by night; 26 hr. formation; 6 hr. acrobatics; 28 hr. instruments, and 20 hr. navigation—15½ by day, 4½ by night. An additional 34 hr. are spent by each student in the Link and T-33 simulator.

Flying in weather that is often marginal—an average of 34% of all Furstenfeldbruck flights are flown under IFR—instructors and students here have amassed a better than creditable safety record, which looks even better in view of the fact that few of the instructors are veterans, and most have been selected to remain behind from among the ranks of the T-33 graduating classes.

In 1959, the 86 T-33s of the Flying Training Squadron here recorded four major accidents, with two aircraft and two instructors lost, during a total of 31,951 flying hr., or 12.5 per 100,000 hr.

This represents a major improvement over the 21 per 100,000 hr. registered

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during a total of 26,289 actual flying hr. in 1958, and 1960 could top 1959.

From the 21,608 flying hr. and 28,048 landings registered by the Training Squadron during the first nine months of the year, only two major accidents were reported.

Average age of the T-33 instructors is 26, and most have been at their jobs for approximately one year and a half. Their average jet time is between 600 and 700 hr., although "we have a couple on hand" with more than 1,000 hr., according to one top official, who adds:

"Our tactical units are still building up. They don't have any surplus, and they won't give us experienced pilots back, so we have to pick young pilots here to do the job."

NCO Instruction Problems

At present, one out of four of the instructors is a non-commissioned officer, but the air force as a whole hopes to phase out NCOs from jet operations over the next four to five years as the officer cadre grows. The use of non-commissioned officers as instructor pilots can cause obvious problems of discipline, respect, protocol and procedure, particularly when the student happens to be an officer, as he often is.

On cross-country flights, for example, the instructor is in charge of the aircraft and, on landing, must take care of all the necessary forms, sign the maintenance checks, obtain the necessary clearances, etc.; in other words carry out the full role of an aircraft commander, while his officer student stands by. Afterward, the officer is wheeled off to the BOQ, the student to the enlisted man's mess—an embarrassing situation for all concerned.

However, in the build-up of the West German air force which began in early 1956, it has been difficult to recruit sufficient applicants with the minimum qualifications of an officer candidate, and lower ranks have had to be accepted for pilot training.

As more officer pilots become available, the NCOs will be phased out of the service as their enlistments expire on a voluntary basis or else be shifted to the transport arm or to non-flying status. A few may become officers, although officials here agree that "it's not very easy for a young man to change his rank."

Since German pilots began training again at Furstenfeldbruck in 1956, one NCO has been selected as having the necessary attributes for officer's training. Once selected, he was sent to a six-month general education course and then through a year-long training at officer's school. Upon completion of the course he was assigned to a tactical unit.

Initial minimum education require-

NON-COMMISSIONED instructor briefs officer pilot students on flight characteristics of the North American T-6 primary trainer.

ments for a pilot officer candidate are essentially the same as those of the U. S. Air Force and Navy—at least four years of "public school" plus nine years of "high school," with a basic grounding in math, physics and geography. Minimum age upon enlistment is 19.

Requirement for a non-commissioned pilot candidate include a minimum of eight years in "public school" plus three-to-four years training as an apprentice in a technical skill. His age is usually 18 to 19.

Both groups to be considered for pilot training must sign up for a minimum of six years as "temporary" officer or non-commissioned candidates. Both can extend their service commitments on a "temporary" basis to a maximum of 12 years.

Most pilot-officers, however, apply to transfer to "professional" status upon completion of their flight training roughly three years after entering service. If he remains as a "temporary" officer, however, and leaves service after six or 12 years, he receives a cash bonus upon discharge plus a fixed income for a stipulated period of time to help tide him through his transition to civilian life.

A captain, for example, retiring after 12 years of service would receive a cash bonus plus 75% of his monthly salary each month for the succeeding two and one-half years.

On the non-commissioned side, such payments are balanced by in-service training beginning after the fourth year of enlistment to prepare the NCO for a better civilian job upon discharge than the one he had upon entering service. This normally consists of two months of schooling each year, or 16 months during a 12-year enlistment.

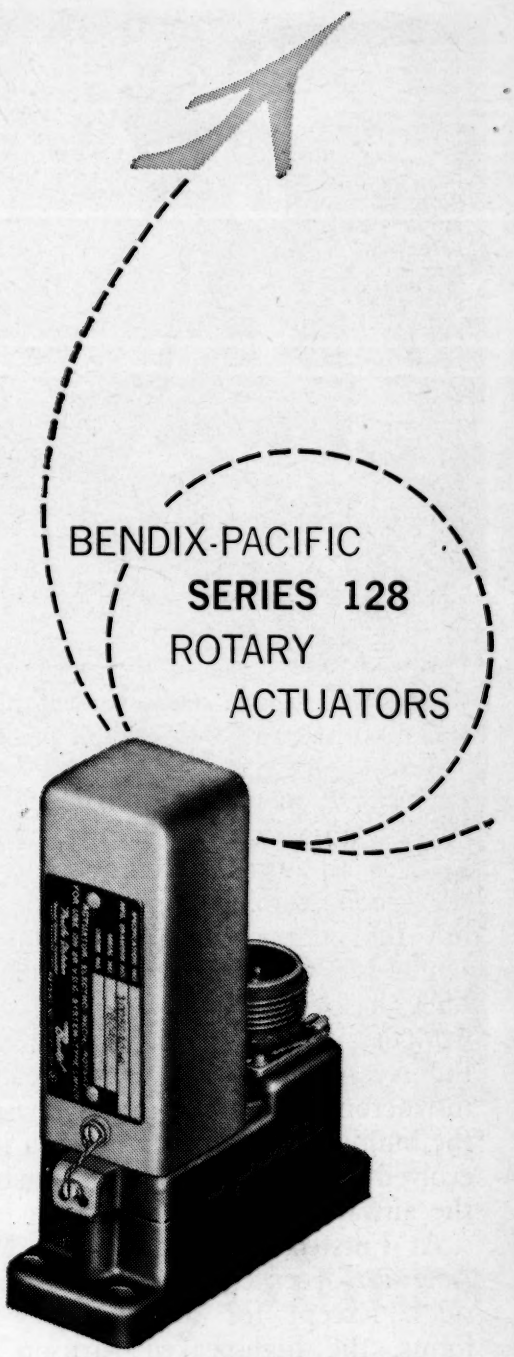
All pilot trainees, officer and non-commissioned candidates, begin service with three months of basic training at one of four sites. This is the usual basic to provide the cadet with the rudiments of military training plus a heavy dose—approximately 16% of his total workload—of indoctrination as to just why West Germany needs an effective air force in face of the Soviet threat to the East.

"We have very little political training in our schools these days," one officer explains, "so we have to provide it here."

After basic, the officer candidates are routed to Neubiberg air base for six months of officers' training, and the noncoms break off for three months of NCO training.

If an officer candidate successfully completes the course, he emerges as a cadet NCO, roughly the rank of a sergeant, and at the end of two years of service automatically becomes a second lieutenant whether he has completed his flight training or not—most often he has not—or whether he has washed out and is holding down an administrative or technical post. The NCO cadet emerges from this training as a corporal.

Next step is preflight training at Utersen near Hamburg, which requires roughly nine months to complete and



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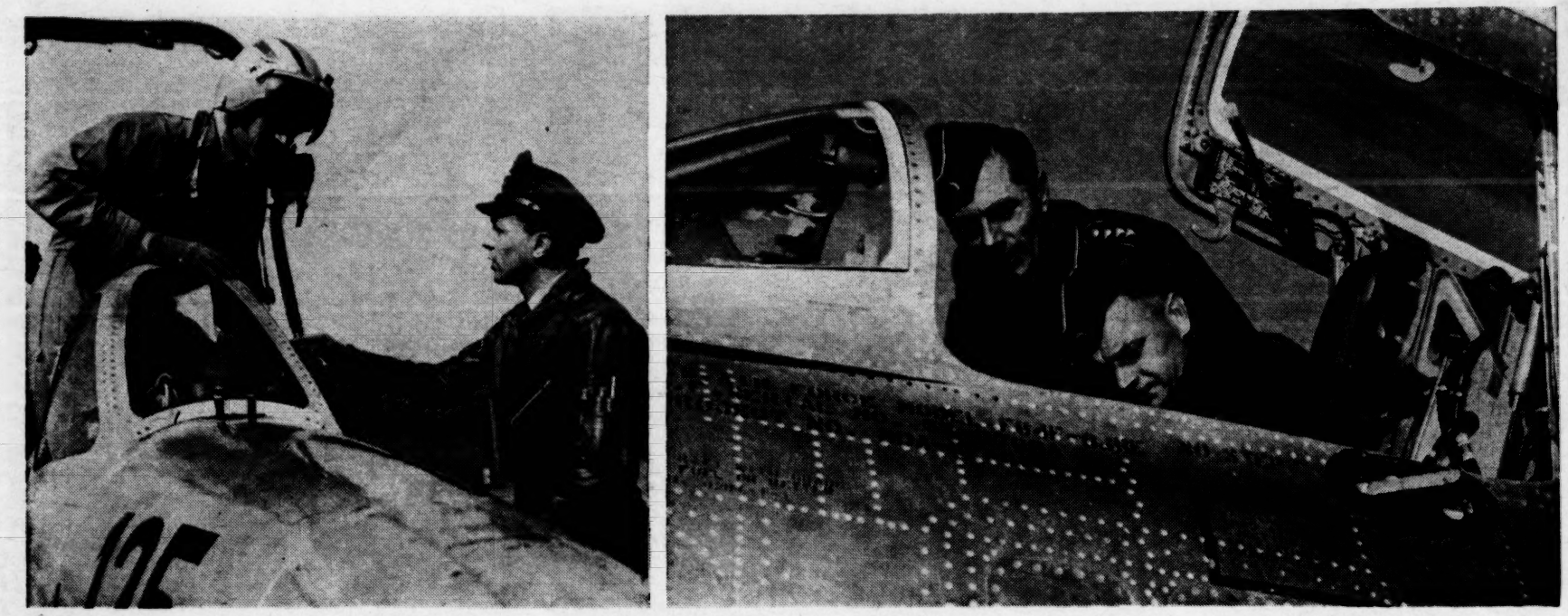


GERMAN instructor meets student pilot after solo flight in Fouga Magister primary aircraft. Student pilot in operational training phase is checked out in F-84F cockpit procedures by instructor captain.

includes a six-month course in basic English plus 25 hr. of flying in a Piper L-18 as an initial screening process.

A good working knowledge of English for pilot and top technical personnel is essential since the German air force has chosen the language as its work-day tongue—partially because of the necessity of working with American instructors during the initial phases of the buildup and partially because it has evolved as the international language of the airways.

At Furstenfeldbruck, English, often American-accented, pours in from all sides. Except for the slate-grey uniforms, the high-peaked garrison hats and the black, red and yellow flag of the German Republic, it sometimes seems as though the base is still under the aegis of the U. S. Air Force. Flight plans are filed in English. The tower crackles with the language.

Another basic reason for the adoption of English is the fact that it probably is much easier to teach the cadet a new language from scratch if need be than to tackle the task of accurately translating all the maintenance manuals needed to maintain the largely-U. S. equipment used by the West German air force.

"I don't know how you could possibly translate 'tailpipe' into acceptable German," one officer explains.

Although six months is programed for the English course at Utersen, the actual time fluctuates according to the individual student's prior knowledge of the language and/or his ability to grasp it. For one student it may be only four months, while another may require eight.

Students from northern Germany, for example, normally have had several years of English in their public schooling. In southern Germany, however, the second language in schools is French.

After successfully completing his English and slipping through the L-18 screening at Utersen, the cadet may go one of three ways:

• **To primary flight school** at Schule A, Landsberg Air Base, for training on either the T-6 or the Magister.

• **To the United States,** if he is scheduled to become a fighter-bomber pilot, to complete his instruction through the basic training phase. Fighter-bomber candidates are particularly signed out for training in the U. S. because of the availability there of training areas for air-to-ground gunnery, bombing and special weapons training and their relative scarcity here. West German government pays the U. S. approximately $40,000 to cover the cost of each student sent there.

Upon their return from the U. S., pilots are routed through Furstenfeldbruck for an additional 25 hr. flight training before assignment to operational training units. Major reason for the training is to give the pilots additional instruction in all-weather flying since the weather over U. S. training schools in the South and Southwest is more often good than bad, while in Germany it is more often marginal than not. Flights also are used to familiarize the pilots with West European communication networks and to impress upon them the nearness of West Germany's borders, particularly those to the East.

• **To primary flight school** on the P. 149 at Diepholz.

In addition to his 110 flying hours at primary, a cadet receives between 250 and 300 hr. of academic and technical training.

From primary school, if he has remained in Germany and if he is not scheduled for the G. 91, the cadet advances to Furstenfeldbruck and the T-33. This requires approximately nine months before the pilot, now a full-fledged one, moves on to an operational training unit for 80 hr. of tactical training, including air-to-air and air-to-ground gunnery. Afterward, he is assigned to his operational squadron where he receives another 35 hr. of combat readiness training.

Over-all, the Training Command has a total of approximately 26,000 officers and men—about half of them students—and is the largest single command within the West German air force.

Its head, Gen. Werner Panitzki, a World War II bomber pilot and a member of the Luftwaffe staff with the rank of lieutenant colonel at the war's end, says the command has now reached its required strength and should be able to handle the air force needs in pilots and technicians in the future.

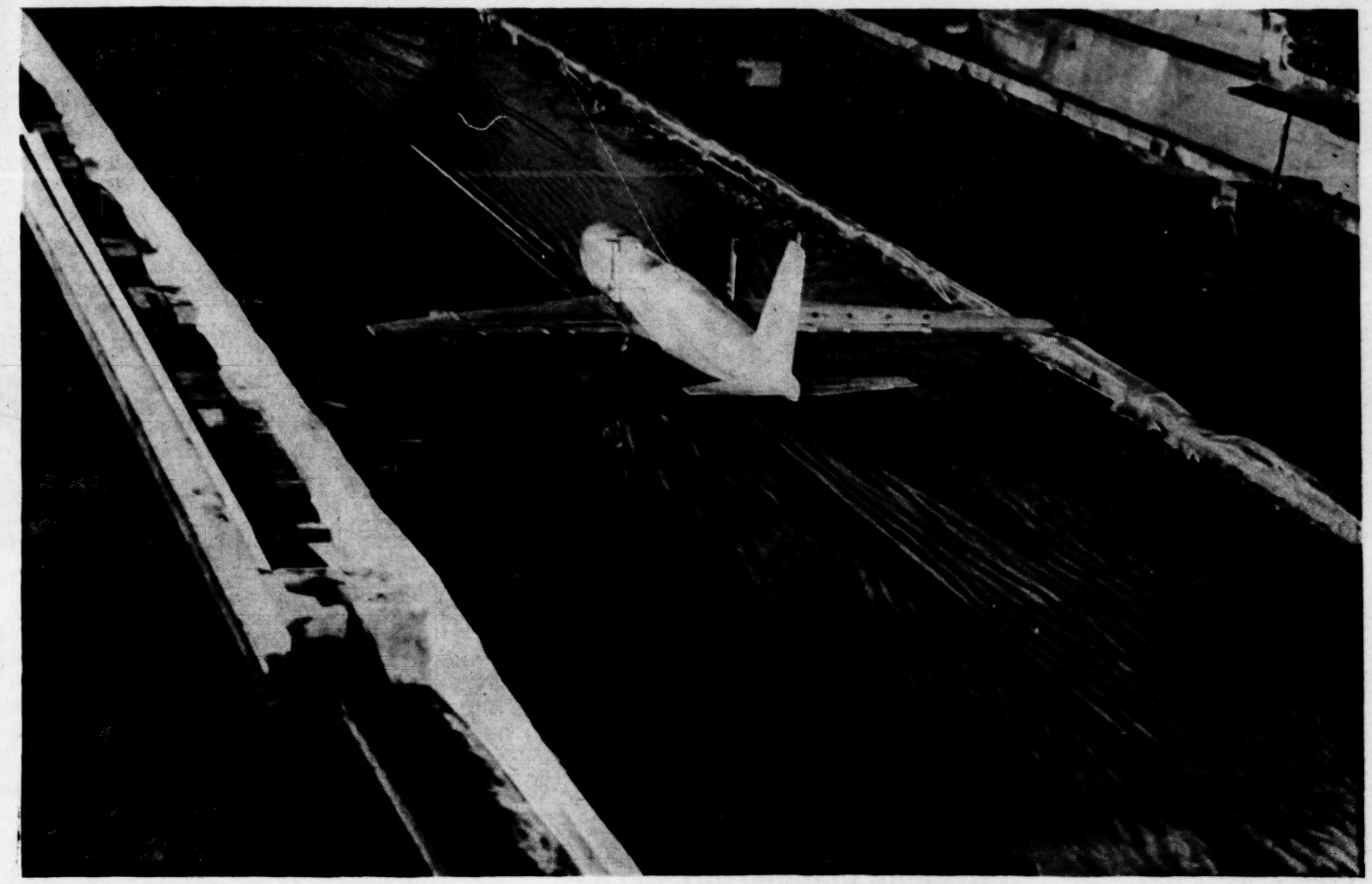
Gen. Panitzki believes, however, that the air force will have to continue to rely upon the U. S. for aid in training its pilots during the final build-up stages through the mid-1960s.

The Training Command itself began to take shape in February, 1956, under the guidance of USAF instructors and supervisory and maintenance personnel and a nucleus of six German officers recruited from among the ranks of World War II.

By the time Furstenfeldbruck was formally turned over to the German air force in December, 1957, approximately 75% of the instructors were USAF. The phaseout of U. S. Air Force has proceeded step by step as more and more German pilots became available.

Last January, there were 25 remaining. The last departed in June.

There are still four USAF administrative officers at Furstenfeldbruck, however, to help German officers in day-by-day affairs. These four are scheduled to remain for about two more years when Furstenfeldbruck, which originally began turning out German pilots in 1936, will stand again on its own. ◆◆



DIAPHRAGM-COVERED pool of water in runway overrun area is proposed by Nortronics Division to decelerate jet transports on runway overshoots. Above, a 0.043 scale model of a Boeing 707 is decelerated by diaphragm-covered water tank at NASA-Langley.

Overrun Brake Designed for Jet Airliners

Los Angeles—A new type of water brake to reduce jet landing accidents by decelerating aircraft on the runway has been invented by Nortronics Division of Northrop Corp. and has shown promise in scale model tests at National Aeronautics and Space Administration's Langley Research Center.

The device is a diaphragm-covered pool of water in the overrun area beyond the end of the runway and is trade-named Decel. Nortronics officials say that unlike aircraft carrier-derived cross-deck cables and barriers, Decel will be easy and safe for commercial jet transports to use. It will also work with other types of aircraft.

Nortronics is asking Federal Aviation Agency to sponsor a full scale test of Decel. Company officials say it would reduce the hazard of operating jet transports at airports with marginal-length runways. They point out that extension of runways at many airports is impossible or prohibitively expensive. Dr. William F. Ballhaus, Nortronics general manager, estimates the installation of Decel basins on new runways and runway extensions covered in the national airport plan of 1959 would save about $38 million.

The Langley Research Center model tests of the system indicated that Decel slows aircraft more effectively and more safely than an open-water basin. The tests yielded less precise information than had been hoped because of trouble with the launching device which propelled a 0.043 scale dynamic model of a Boeing 707 into proportionately scaled Decel and open-water basins. However, there was sufficient data for a NASA official to announce that Decel deserves further investigation.

The model often bounced and swerved along the runway approaching the test basin after launch but in comparable circumstances the Decel basin brought the model to a halt within a shorter distance than the open-water basin. In several runs the water splashed from the open basin carried away the flaps which were attached at scale strength or did other damage to the model.

There was some damage to landing gear in tests of both basins but the degree of significance to full scale operation is not certain.

Nortronics officials believe Decel will lower the number of accidents caused by landing short of the runway as well as those caused by landing fast or long. At short fields, pilots must fly their approaches with little or no speed or altitude margin and the danger of landing short or stalling is greater. A wet or sloping runway or a hot day can make an ordinarily adequate runway marginal. Dr. Ballhaus estimates wide use of Decel basins would increase airline schedule reliability and open many fields to jet traffic which are now unsuitable if FAA field length requirements were lowered where Decel is in use.

Nortronics ran a computer analysis of the effect of Decel upon rollout after landing and found that with an entry speed of 75 kt., all current American jet transports would be stopped without the use of wheel brakes or reverse thrust after travelling between 60 ft. and 700 ft. in the basin. Top engineers at Nortronics believe that neither the computer analysis nor the model test was comprehensive enough to be the basis of a full-fledged development program. They are recommending a more thorough computer study and another series of scale tests using a fighter plane to simulate larger aircraft.

Advantages claimed for Decel include:

• **Continuous availability** regardless of weather. Water in the basin can be

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Decel slows the rolling airplane as its wheels depress the cover, displace water and build a bow-wave. Under existing plans, entry and exit ramps of the Decel basin would have a slope of about one degree. Designs in which the depth would vary with distance along the basin to give uniform deceleration are now being studied. Nortronics engineers believe more information on basin cover materials is needed before final design can begin.

Much consideration is being given to a flexible mat of laminated glass fiber strips bonded to a nylon-plastic matrix with the laminations on edge and running the length of the cover.

Ridges of the matrix maintain the orientation of the vertical laminations. The cover would have a total thickness of about one-eighth inch and would be tied down to the edges of the basin. The Langley tank tests indicated that Decel functions better with the cover restrained rather than loose.

A number of questions remain to be answered about the proposed device. Above a certain speed, the wheels of an airplane are expected to "water ski" along the surface without displacing enough water to provide much braking. Test indications are that for many load conditions, the nosewheel may water ski at a lower speed than the main wheels.

The effect of this on main gear structure remains to be shown.

The deceleration levels which can be tolerated by landing gear structures under a wide range of conditions comprise one of the most important areas needing further study. Initial calculations were based on the assumption that landing gear could withstand a peak deceleration of 0.8g. Since then, engineers have learned that the ultimate load for the nosewheel of at least one U.S. jet transport is only 0.25g.

If engineering cannot completely eliminate the possibility of structural failure, FAA and the industry will have to judge whether the probability of damage is acceptably low. Economic considerations may show that savings returned by Decel are high enough to warrant design and retrofit of stronger, heavier landing gear. ◆◆

PRODUCTION BRIEFING

North American Aviation's Columbus Division has received a $1,844,000 contract to build a 120-ft. solid-face reflector radar antenna for the Air Force. To maintain the curvature of the antenna, NAA plans to use tension rods instead of the usual brace members. The tension of the rods will be adjusted by turnbuckles and measured by tone or pitch. The antenna will be operated for M.I.T. by the Air Force and will be situated at Tyngsboro, Mass.

Raytheon Co. has been awarded a $5.2-million contract to produce and install nine long-range radars for the Federal Aviation Agency's air traffic control network. This brings to 52 the total of radars that Raytheon is producing for FAA. The nine radars called for by this contract and eight others ordered in April, 1960, are designated ARSR-II (Air Route Surveillance Radar) and have antennas measuring 50 by 25 ft. in contrast to the ARSR-I's which have 40 x 11 ft antennas. In addition, the new radars are equipped with Amplitron power tubes which will give them a range of more than 200 naut. mi.

Stromberg Carlson Division of General Dynamics Corp. has been awarded five contracts totaling more than $12,000,000 for communications systems for Air Force Titan missile bases. The contracts provide for the design, development, liaison and engineering of communication systems at Air Force Titan missile squadrons and for the manufacture and installation of the systems at the first four Titan bases.

Raytheon Co. has been awarded a $7.5-million contract by Sperry Gyroscope Co. to continue production of search and doppler radars for the Convair B-58 Hustler. Sperry is currently producing the Hustler's bombing and navigational system.

Chrysler Corp.'s Michigan Ordnance Missile Plant, Sterling Township, Mich., will perform the work on a $1,321,590 contract for component modification and related engineering on the Jupiter IRBM. To date, Chrysler has received $296,060,311 worth of contracts for production of the Jupiter.

Fairchild Semiconductor Corp. has been awarded a $1,381,105 contract for high-reliability transistors by Autonetics Division of North American Aviation, Inc. The transistors will be used in the inertial guidance and flight control equipment on the Air Force's Minuteman ICBM.

General Electric's Missile and Space Vehicle Department in Philadelphia, Pa., has been awarded contracts totaling $1,600,000 for fabrication and test of airframes for the Army's surface-launched free-flight and Automet test vehicles. The free-flight rockets and test vehicles are designed to test components and systems for future weapon systems.

Martin-Orlando has received a $1,037,169 contract from the Army Ordnance Missile Command for components for Lacrosse close-support missile system.

Computer Engineering Associates, Inc., Pasadena, Calif. has been awarded a $61,000 contract by Convair Division of General Dynamics Corp. for power supply instrumentation used in the telemetering system of the Tartar missile. The power supply provides continuous output power of 100 w. and any one specified voltage from 150 to 300 v.d.c. with an input of 22 to 29 v.d.c.

Chance Vought Corp.'s Aeronautics Division, Dallas, Tex., will manufacture horizontal and vertical stabilizers for the North American B-70 bomber.

Fairchild Camera and Instrument Corp., Syosset, N. Y., will produce electronic test equipment for the Boeing B-52 bomb-navigation system under a contract from International Business Machines Corp. The test equipment, designated AN/ASB-9A, will be produced by Fairchild's Dumont Military Electronic Dept., Clifton, N. J.

Linde Co., a division of Union Carbide Corp., will build a plant at Fontana, Calif., capable of producing 26 tons per day of liquid hydrogen. Under the terms of a $31,000,000 contract, the plant will deliver 21 tons a day to NASA. In addition, the contract calls for Linde to ship 75 to 300 tons per month of government owned liquid hydrogen from Florida to the West Coast commencing June 1, 1961, until the completion of the Fontana plant. Linde is modifying part of its fleet of tank cars to transport the liquid hydrogen and will build 25,000 gal. tanks cars and special highway trailers to deliver liquid hydrogen to NASA use points.

General Electric Ordnance Department, Pittsfield, Mass., has been awarded a $34,000,000 letter contract for the manufacture of the Mk. 84, an advanced fire control system for Polaris-firing submarines. First installation of the new system, which is more automatic than its predecessor, the Mk. 80, will be in the USS Lafayette (SSBN-616).

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- Convair Astronautics—QCS-270-10-3—0-75001—0-75002—0-75035
- AMF Procedure Specification—ARS-1061-A
- Rocketdyne—RA0110-004
- Martin Company—Q.C. 106—804-1310000—327-9020000—327-9020001
- Aerospace Industries Association of American Incorporated. Handbook for Contamination Control of Liquid Rocket Propulsion Systems.

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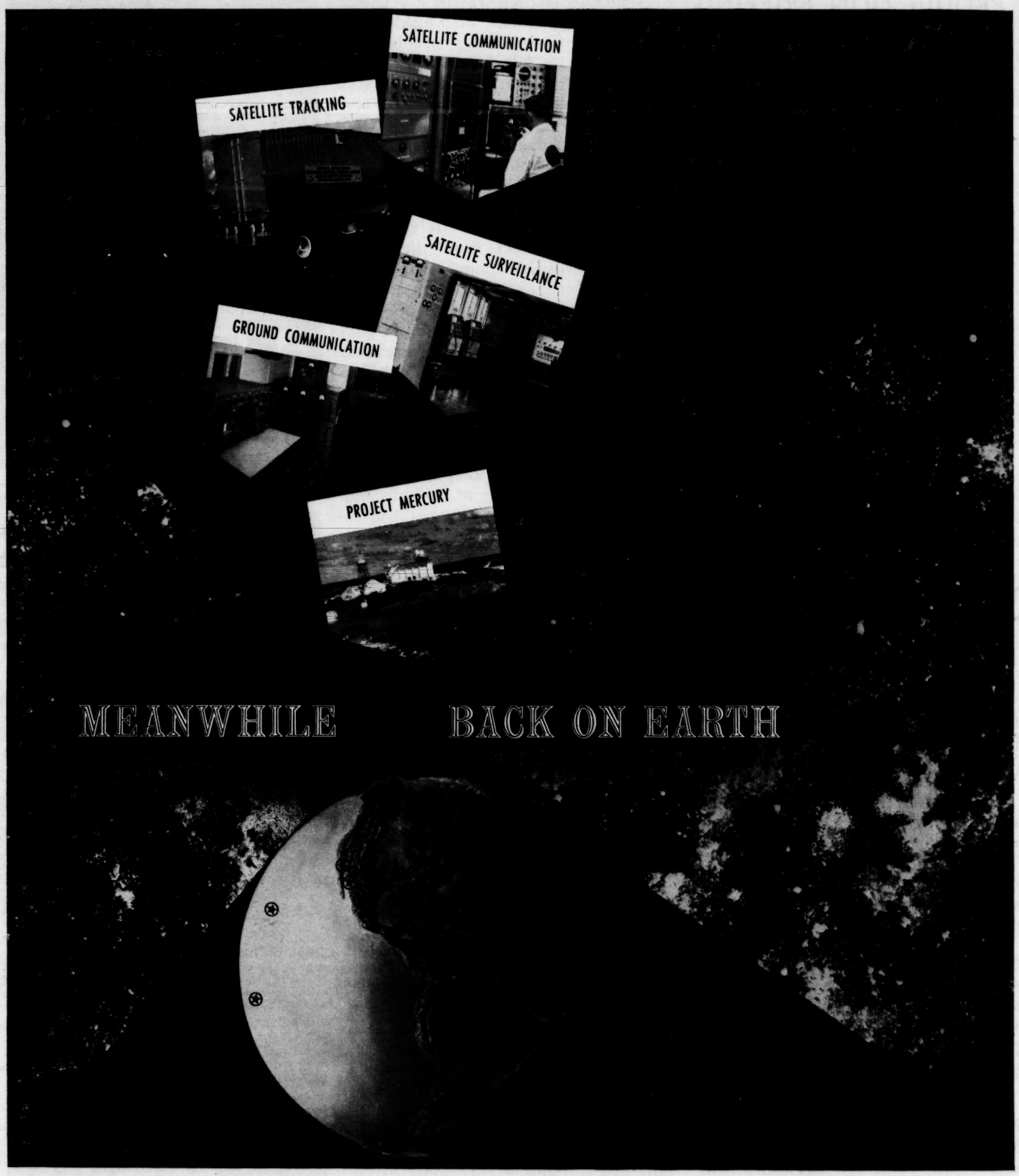

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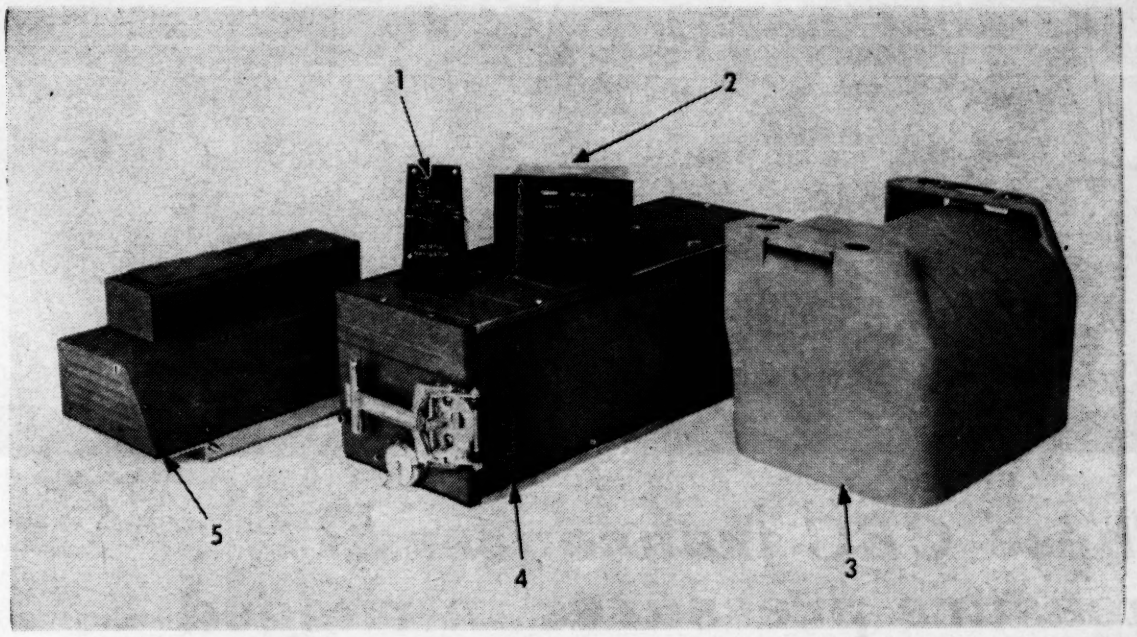
Litton Is Producing F-104 Inertial Navaid

By Barry Miller

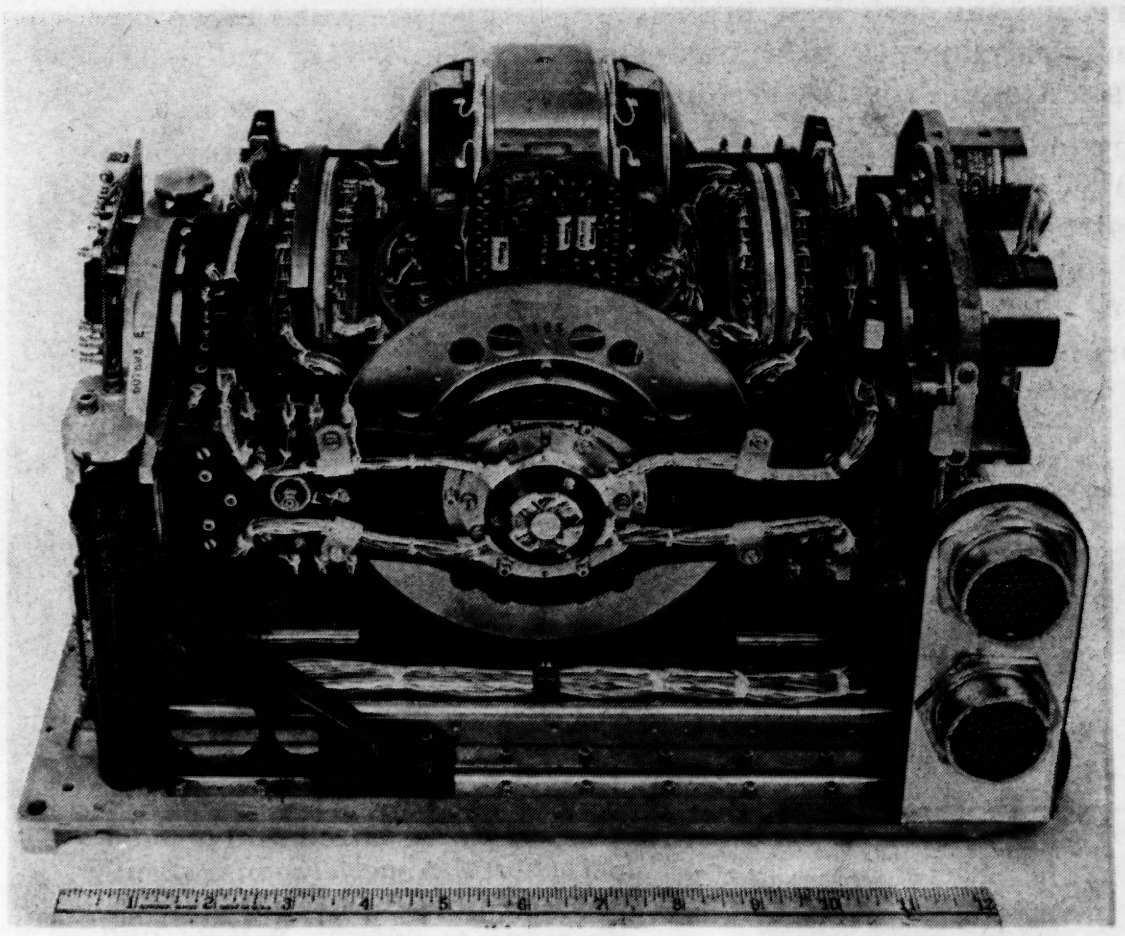
Beverly Hills, Calif.—Lightweight inertial navigation systems scheduled for use in at least 400 Lockheed F-104 supersonic fighters destined for several foreign nations can pinpoint a fighter's position within a mean circular error of 1.5 naut. mi. for each hour of flight, recent flight tests indicate.

The inertial systems, which weigh slightly less than 80 lb. each, were designed and are being produced here at the Guidance and Control Systems Division of Litton Systems, Inc. Litton's system, designated LN-3, is believed to be the first production inertial system to be employed in operational fighters, although a North American Autonetics system was flight-tested in an F-86 Sabrejet some years ago. Flight tests of the LN-3, now in progress and expected to continue until late this year, are being conducted jointly by Lockheed Aircraft and Litton.

Litton has production orders from Lockheed and the Canadian government for 400 of these systems, according to Dr. W. J. Jacobi, manager of the division. They will provide the basic navigation data needed to guide the fighters to any one of up to 50 preprogramed targets without reliance on ground-based navigation aids or externally radiated signals. In-house orders cover inertial systems for the CF-104s to be used by the RCAF and F-104Gs going to Germany, The Netherlands and Belgium.



LIGHTWEIGHT (79.8 lb.) inertial navigation system made by Litton Systems, Inc., will be basic navigation unit of Canadian, German, Belgian and Dutch Lockheed F-104 supersonic fighters. It consists of (1) navigate control (2) align control (3) platform (4) computer and (5) adapter.



STABLE PLATFORM of Litton inertial navigation system uses two two-degree-of-freedom gyros, the upper one of which is visible in center.

Test Maneuvers

As part of the tests, two F-104Cs modified into an F-104G configuration and navigated by prototype LN-3 systems made over 50 flight tests through a wide range of flight profiles. In one recent test, for example, the aircraft flew through the following typical fighter maneuvers during a 1-hr. 32-min. period:

- **Loft low** at 6,000 ft. into Immelmann.
- **Loft low** and medium steep pull-up.
- **Loft high** and pull up at 5g into a **tight Immelmann.**
- **Loft over shoulder** at 5g.
- **Dive high** at 7 to 20 deg.
- **Dive low** at 15 to 45 deg. at Mach 0.95.

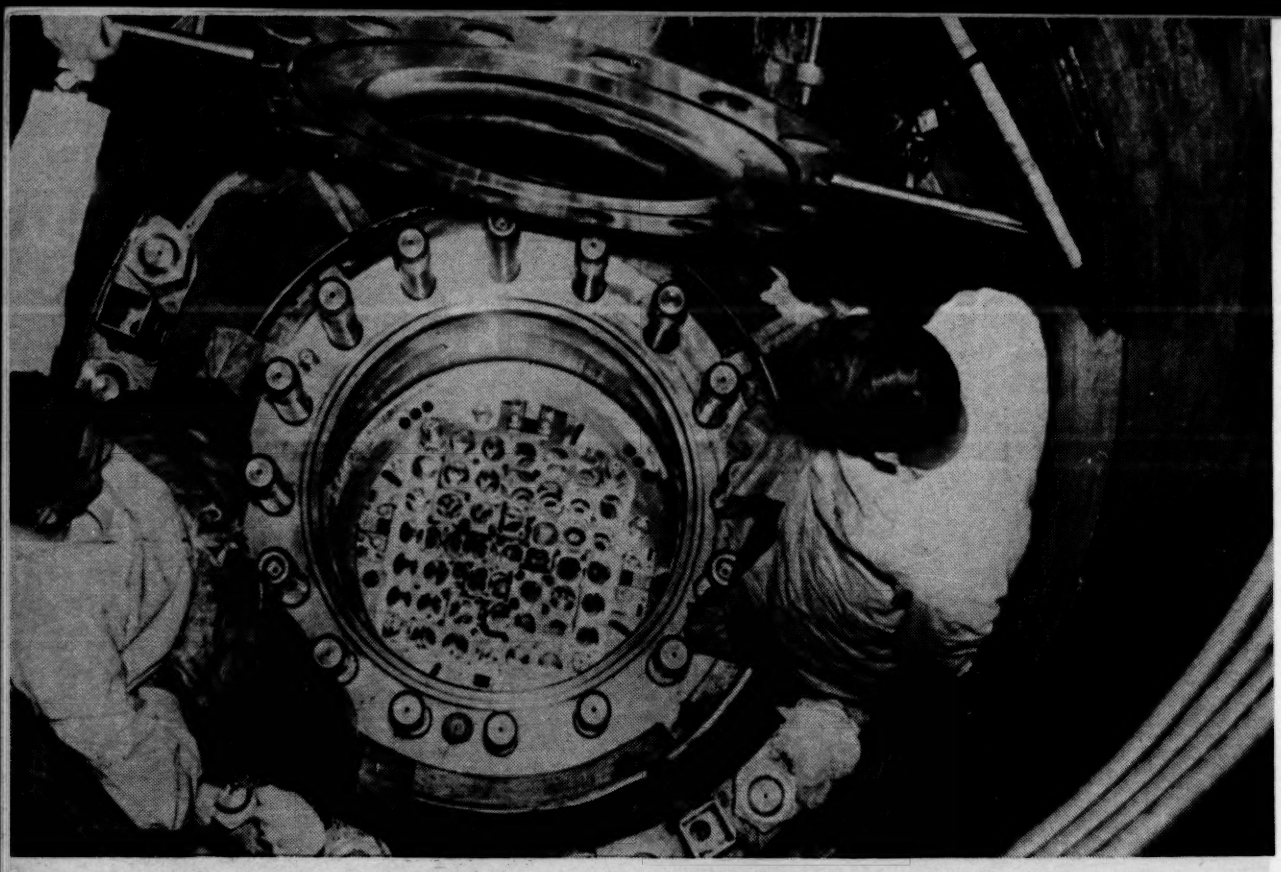
At the end of this flight, the aircraft's position, indicated by the inertial system, was 1.5 naut. mi. from its actual position. The average error buildup for the 50 flights was 1.3 mph. (naut. mi.), Litton reports. Some of the errors were as low as ½ mi. at the end of an hour's flight. Altitudes up to 75,000 ft. were reached without system failures during the flight tests, the company adds.

In addition to providing aircraft position, which may be shown in range and bearing to the destination on a cockpit display, the inertial system supplies airplane ground speed, heading and attitude.

Accuracy of this data, according to Litton, is as follows:

- **Groundspeed** within 2 fps.
- **Heading** within 6 min. of arc.
- **Attitude** within 3 min. of arc.

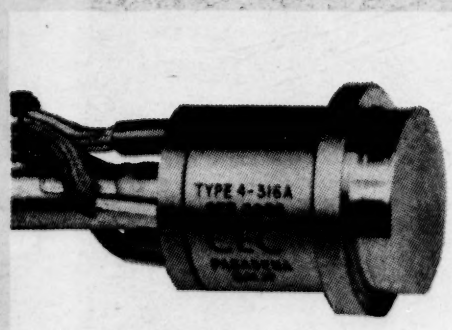
Up to 27 outputs, functions of pitch, roll and heading angles, are provided for



***These CEC transducers measure pressures in rugged* HIGH TEMPERATURE AND NUCLEAR ENVIRONMENTS**

Here are the two best high temperature pressure measurement instruments in their range: CEC's 4-316 and 4-317 Strain Gage Pressure Transducers.

They operate continuously and accurately at temperatures to 600°F. in a variety of applications—from engine and structural testing for the aircraft and missile industry to use in the high radiation environment of nuclear reactor cores (*see photo above*). In cryogenic laboratory applications, they are operable down to 1/10 of a degree Kelvin.



Low Pressure Type 4-316* more than doubles the temperature range of ordinary pressure transducers... can actually withstand 650°F. It is available in gage or uni-directional differential models in pressure ranges of 0-15, 25, 50, 100 and 150 psig or psid. In bi-directional differential models, the 4-316 is operable in pressure ranges of ±7.5, ±12.5 and ±25 psid. *Bulletin CEC 4316-X1.

High Pressure Type 4-317* measures gage pressures of from 100 to 5000 psi at 600°F. A special cooling adapter used with the instrument extends its range to 2000°F. *Bulletin CEC 4317-X1.

For further information, write for bulletins or call your nearest CEC sales and service office.

Transducer Division CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

airborne equipments necessary for such missions as reconnaissance, ground mapping, terrain avoidance and bombing. These outputs are made available from an adapter unit, included in the system and consisting of the heading servo system and servo follow-ups.

The entire inertial system—stabilized platform, analog computer, adapter and navigate and align controls—weighs 79.8 lb. The stabilized platform alone, developed under a program sponsored by the Flight Control Laboratory at Wright Air Development Division, accounts for 30.6 lb. of the total.

A working model of a later generation system, which will match the LN-3 in accuracy yet halve its weight, is expected to be ready in March, according to Harold F. Erdley, director of engineering for the Guidance Division. The platform of this system (LN-4) will weigh about 15 lb., Erdley says. Along with conventional fluid gyros, it will employ novel gas spin bearing gyros which should ensure long life and reliability in the absence of bearing friction. Operating prototypes of this new gyro have provided measured random drift rates lower than 0.001 deg./hr., Erdley says.

Stabilized Platform

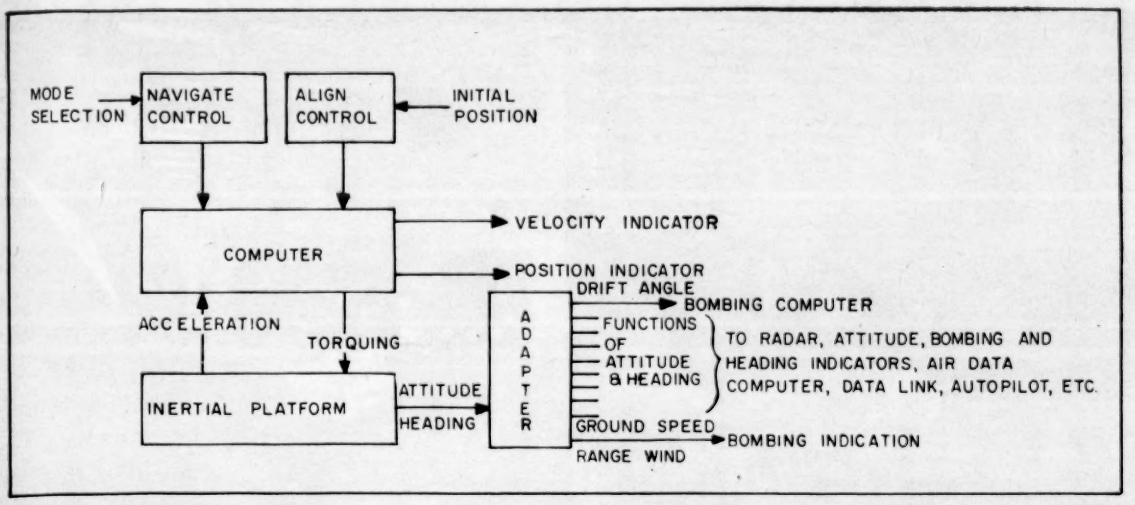
The stabilized platform of the LN-3 is a three-axis, four gimbal mechanism. It uses two two-degree-of-freedom gyros and three non-integrating, torque-balance accelerometers (one for each axis). It maintains an earth-fixed navigation reference system throughout complex aircraft maneuvers.

Litton employs two-axis gyros instead of the more widely used single-degree-of-freedom gyros. This reduces the number of gyros required from three to two and permits a high gyro angular momentum to be achieved on a relatively small platform. The gyros provide random drift rates of 0.01 deg./hr.

Floated gyros employed in the system are mounted on the stable platform with their spin axes horizontal and at right angles to each other. The gyro rotor spins at 24,000 rpm. inside a spherical float mounted in a floated gimbal ring by a pair of jewel and pivot bearings. The second degree of freedom is provided by positioning the ring to the external case with another pair of jewel and pivot bearings.

During system operation a servo loop senses relative motions between the gyro case fixed to the platform and the gyro float fixed in space. This keeps the platform and accelerometers which are mounted on it properly oriented.

Accelerations along the three axes defined by an earth-fixed coordinate system are measured by the accelerometers, integrated twice to arrive at position coordinates. Distance and bearing to the plane's destination are com-



BLOCK DIAGRAM of Litton's inertial navigation system shows outputs of system adapter.

puted and are available for display.

Each non-integrating accelerometer weighs 7 oz., occupies 2½ cu. in., and can translate accelerations into electrical outputs to an accuracy of five parts in 100,000, the company explains. Sensitive element in the accelerometer is a floated pendulum mounted on jewel and pivot bearings and equipped with a sensitive pickoff and precision torquer. Torquer signals, a direct function of any sensed acceleration are continuously fed to velocity integrators in the navigation computer.

Analog Computer

An analog computer unit houses platform stabilization avionics, navigation computer and the system power supply. High-density component packaging and use of multi-layered etched laminate wiring harnesses are responsible for much of the compactness in the computer. It is in the navigation computer that accelerations are integrated once for velocity, twice to obtain position. This computer also calculates gyro torquing rates for holding the stable platform in proper orientation regardless of latitude. An analog, rather than a digital, computer was selected for this system, Erdley says, because tight scheduling did not permit design of a digital unit small enough for this system.

Pilot Procedures

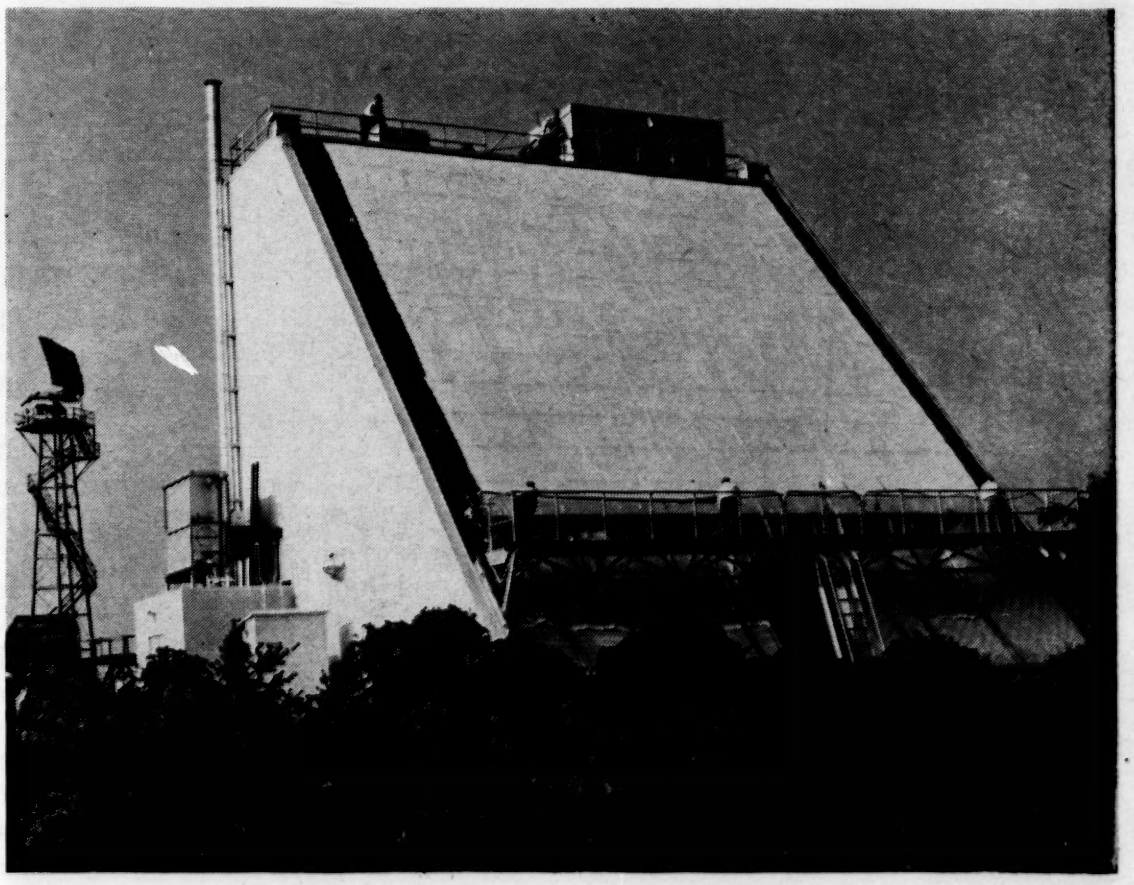
To operate the system, the pilot goes through the following steps in preparing for flight:

- **Inserts his initial position** coordinates into the align control.
- **Turns a mode selector switch** on the align control from "off" to "align." This energizes the system and brings gyros up to speed. The system automatically goes through a self-contained leveling and gyro compass alignment phase to level the platform and align it in azimuth.
- **Switches to "navigate"** after the "align" sequence is completed and indicated by a flashing lamp. In this mode, the gyros are torqued to hold the stable element of the platform oriented in level perpendicular to the local vertical. The stable element is oriented in azimuth to north in a grid coordinate reference system, based on a spherical reference system which has its pole in the earth's equatorial plane and its equator in the plane of the base meridian. The base meridian, Litton explains, is the meridian of longitude passing through the initial base position and set for any flight by the initial longitude coordinate put into the align control.

In the event of a malfunction, the pilot can switch into a "compass only" mode, thereby removing power from the system. Magnetic heading from a flux valve compass is then available as the heading output of the adapter.

The LN-3 inertial system occupies a total of 1.87 cu. ft., including all accessory and cockpit controls. System power consumption is 520 watts. The stabilized platform is designed to operate over a temperature range of −55C to 55C, while the associated avionic units can operate up to temperatures of 71C. System design objective calls for an operating life of more than 5,000 hr. and a storage life of five years.

Although Litton has achieved a dominant position in the field of inertial navigation systems for aircraft, it is not now supplying inertial systems for missile use. The company will soon begin rocket sled tests of its inertial systems at the Naval Ordnance Test Station at China Lake to qualify them for missile use. ◆◆



Array Radar Tracks Multiple Targets

Electronically Sterrable Array Radar (ESAR), whose beam can be scanned from any point in its coverage to any other in less than 20 microseconds, permitting tracking of multiple targets simultaneously, is ideally suited for use in ballistic missile defense and space surveillance. Developed by Bendix Radio, under Air Force and ARPA sponsorship, the ESAR is near Baltimore. The radar employs 8,768 small antenna elements, potted in foam, which make up the 50 x 50 ft. sloping face of the structure. By connecting individual transmitter and receiver to each antenna element, extremely powerful radar beam can be formed. Beam is shaped and caused to scan by controlling phase of radiation from each antenna element. Received signals also are delayed by equivalent amount to preserve relative phase relationship of all elements. Radiation and reception pattern is controlled by digital computer. By means of a time-sharing arrangement, and selection of proper antenna elements, simultaneous scanning and tracking of multiple targets is possible. ESAR shown is capable of exciting only 760 of the 8,768 antenna elements, but more can be activated in the future. Radar is oriented to permit it to view air traffic between Baltimore and Washington and missiles launched from NASA's Wallops Island station.

AIRCRAFT Installation Diagnostic Equipment (AIDE) can quickly pinpoint faults external to major black boxes in the AN/ASQ-37 communication-identification-navigation system used in F-105D. Each of orange-colored boxes being used by AIDE operator (left) simulates operation of one of ASQ-37 black boxes, permitting quick, direct check of all external circuitry, controls and instruments.

Tester Checks F-105 External Circuitry

By Philip J. Klass

Cedar Rapids, Iowa—New type of test equipment, intended to speed initial installation and subsequent maintenance of multi-component avionic subsystems, will be demonstrated to Air Force this month for the first time at Nellis AFB.

The Aircraft Installation Diagnostic Equipment, or AIDE for short, was developed by Collins Radio Co. for use with the AN/ASQ-37 communication-navigation-identification (CIN) subsystem on the Republic F-105. But the basic technique is applicable to a wide variety of avionic equipment installations.

At a time when there is great emphasis on extremely sophisticated, high-speed automatic checkout equipments, the Collins AIDE is novel in its simplicity and its approach. AIDE is not intended to check out any of the six black boxes which form the heart of the AN/ASQ-37. Instead, it checks out and pinpoints faults in the external input-output sensors, cockpit instruments and interconnecting cables with which the ASQ-37 must operate.

The AIDE approach is ideally suited to an avionic subsystem, such as the ASQ-37, which consists of approximately 20 black boxes, external sensors, controls and cockpit instruments. The ASQ-37 installation includes the following major black boxes:

- **AN/ARC-70** UHF communications set.
- **AN/ARN-61** instrument landing package, including localizer, glide slope and marker beacon receivers.
- **AN/ARN-62** Tacan navigation transmitter and receiver.
- **AN/ARA-48** UHF direction finder.
- **AN/APX-37** IFF transponder (produced by Hazeltine Corp.).
- **Power supply.**

In addition to these major black boxes, the subsystem contains an AN/AIC-20 intercommunications set, UHF, Tacan and instrument landing controls for selecting frequencies and entering other input parameters, plus cross-pointer, Tacan and RMI indicators. Additionally there are antennas for the Tacan, UHF communication set, instrument landing package and direction finder.

With approximately 20 individual elements making up the ASQ-37, isolating a fault to the appropriate component or interconnecting cable, can be extremely time-consuming.

'Substitution' Method

To understand the value of AIDE it is necessary to recognize the "trouble-shooting by substitution" procedure frequently employed by maintenance personnel. Because the six black boxes which form the heart of the ASQ-37 are the most complex elements in the subsystem, they naturally are suspected first when the pilot reports a fault.

And because these black boxes are conveniently mounted on a single, easily-accessible rack in the belly of the F-105, the usual first step is to pull out the questionable black box and substitute a new one.

If the basic fault is in one of the external controls or in the aircraft wiring, substitution of a new black box does not correct the trouble. But this may not be discovered until after another flight is made because many functions cannot be fully checked out on the ground.

An unimaginative or unskilled maintenance man may go through the black box replacement routine several times before he recognizes that he must dig into less accessible locations for the fault.

Certain types of faults external to one of the major black boxes may result in burning out elements of each new black box substituted until the maintenance man recognizes that the basic trouble lies elsewhere.

The Collins AIDE for the F-105 consists of five boxes, one corresponding to each of the five black boxes which the company builds for the ASQ-37 subsystem. Each of the AIDE boxes is the same size as its operating equivalent, and plugs into the same spot on the rack.

If, for example, the pilot reports that his Tacan set is not operating prop-

erly, the maintenance man replaces the Tacan receiver-transmitter with an equivalent Tacan AIDE box. All AIDE boxes are painted bright orange to alert a maintenance man so he will not forget to replace them with operating models.

'Go, No-Go' Tests

With the Tacan AIDE box in place and an observer in the cockpit, the operator uses a check sheet to run through a sequence of "go, no-go" tests using selector switches on the AIDE box. Initially, the AIDE box checks incoming voltages from the power supply, by means of a small panel meter with a "go, no-go" scale marking. Then other incoming signals/voltages are checked.

Following this, the AIDE box generates synthetic Tacan signals corresponding to 0, 55, 95 and 199 mi. while the observer checks the Tacan cockpit indicator to be sure it shows these distances.

Similar signals are generated by the AIDE box to check the bearing indication of the cockpit instrument, as well as its warning flags.

The AIDE box routine includes a check of the external antennas by means of VSWR measurement.

Within several minutes, it is possible to check out all of the external circuits and controls of the navigation portion of the ASQ-37. If a fault is detected, the check list pinpoints its location. If the external circuitry and controls check out satisfactorily, the maintenance man is safe in assuming that the Tacan transmitter-receiver is at fault and that the system can be made operational by substituting a new set from supply.

Self Contained

Each functional AIDE box is completely self contained. This means that a Tacan AIDE box can be used in one aircraft while the UHF communications AIDE box is being employed to check another aircraft. Thus a single five-box AIDE system can service a number of aircraft.

Because the AIDE boxes are simple devices, they are relatively inexpensive. In small quantities, a five-box AIDE for the ASQ-37 is expected to cost somewhat less than $10,000. This is a fraction of the cost of the operational ASQ-37. If the use of AIDE saves burning out a couple of new replacement black boxes during its lifetime, it has paid for itself, according to Arthur Wulfsberg, director of development for Collins' Division "B."

Because of the simplicity of AIDE boxes, they should prove extremely reliable. However, Wulfsberg points out that AIDE is one checkout equipment which does not require a separate tester to check its own operation. The AIDE boxes can be completely checked out on the test benches now used to check the

What is your need for exactitude?... "over there at 3pm" or "5000 yards/212° azimuth/70° elevation/15 hours, 22 minutes, 12.033 seconds PST." The Canoga Model 8476 Radar Telemetry Data Tie-In System provides digital radar determination of range, elevation and azimuth of an object in space with reference to time. A choice of signals generated internally are recorded at from one to 100 per second, stored in binary memory devices and are available as an input to computers, magnetic tape recorders, punched paper tape recorders, printers and other devices. Data printed out from computer processing give time of occurrence; polar and cartesian coordinates of one or more targets corrected for refraction, parallax and earth curvature; dX, dY and dZ of the targets relative to each other; 23 words, 14 bits each, of telemetered data; and more. With the Canoga Model 8476 it is possible to reconstruct a complete trajectory of a given target providing digital evaluation at any time. canoga

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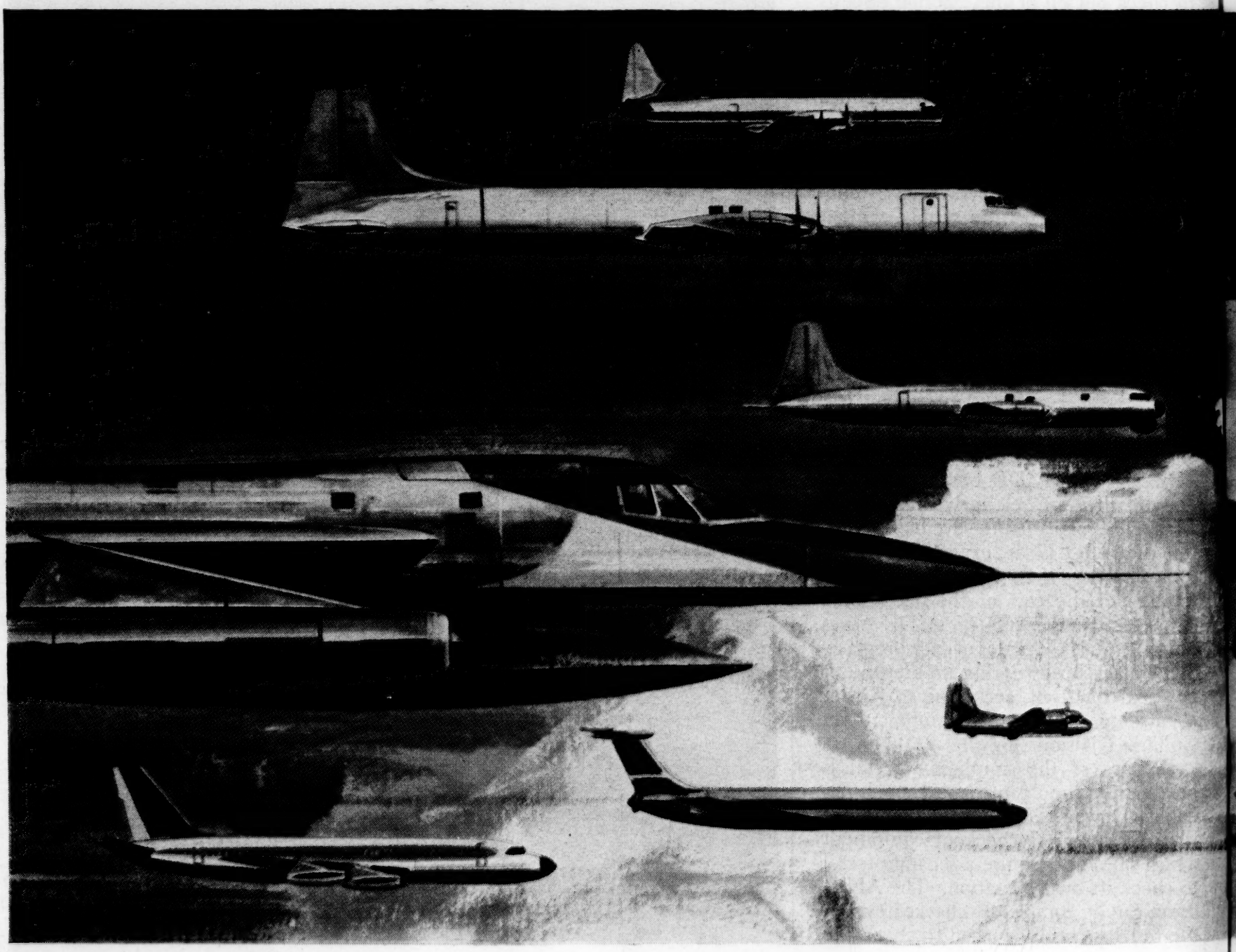
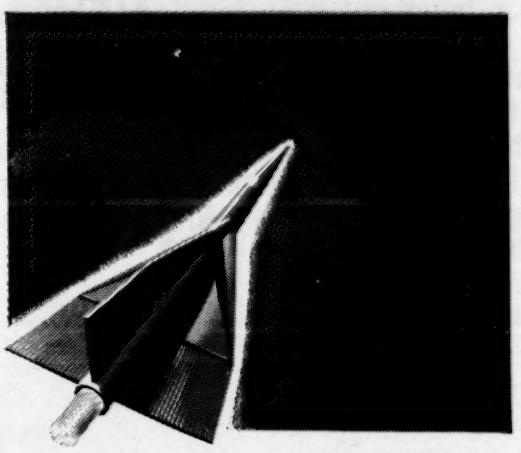


On the record, Bendix® automatic flight control systems qualify as the world's most experienced, most versatile for jet-age aircraft. Besides having flown more than 1,500,000 hours and over half a billion miles with the world's leading airlines, they have logged uncounted hours and miles on aircraft in the daily service of the U.S. and Canadian Air Forces and Navies.

In May 1957, the Bendix PB-20 became the first transistorized flight control system approved for airline use. Variations of it have since become operational on a great diversity of aircraft ranging from the world's first supersonic bomber—the Air Force's B-58 Hustler—to the world's tiniest jet-powered nuclear weapon carrier—the Navy's A4D-2N—and including the gigantic C-133A prop jet transport, the luxurious 707, 880 and Electra airliners, the RCN's deadly CL-28 submarine hunter and killer, and a host of other domestic and foreign aircraft.*

Dependability of these systems is underscored by the fact that many components have earned approval for an 8500-flight-hour overhaul schedule. Bendix flight control experience extends across many fronts including successful performance on rotary winged aircraft and a completely solid state design that already has logged flight time. Our record in the field of flight controls is a direct result of more than 40 years of close association with the operating needs of all kinds of air vehicles.



Another important current activity is a program to develop, build, and test hot gas systems for semi-orbital vehicles and missiles. Further proof that you can continue to look to E-P KNOWMANSHIP for major breakthroughs in flight controls, instrumentation, and components for aircraft, missiles, and space vehicles.

A complete list of the 40 operators and 15 aircraft types which employ Bendix transistorized automatic flight control systems is available on request.

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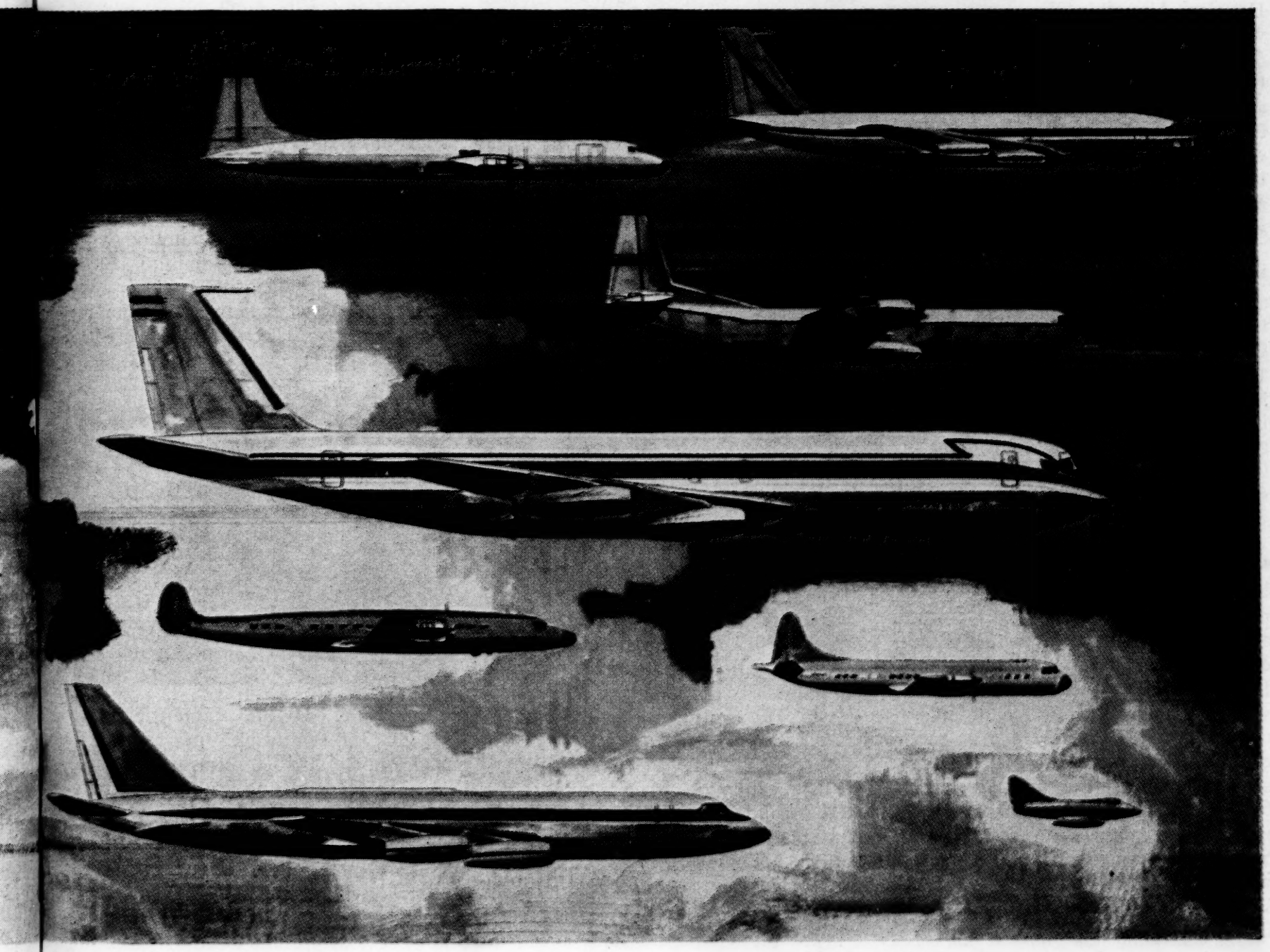


operating ASQ-37 black boxes and system controls.

Collins believes that AIDE can pay its way at an aircraft manufacturers plant, as well as in the field, and has recently demonstrated the system to Republic Aviation. Although Republic now uses automatic test equipment to check out airplane wiring after installation, as well as test benches to check ASQ-37 components before installation, Wulfsberg believes that an AIDE check of the complete installation just prior to installing the six major black boxes would pay off.

Wulfsberg says that experience to date at Republic, and with F-105s now operational with the Air Force, indicates that 25% or more of the troubles result from malfunctions external to the six major black boxes, which AIDE can quickly pinpoint for maintenance personnel.

FILTER CENTER

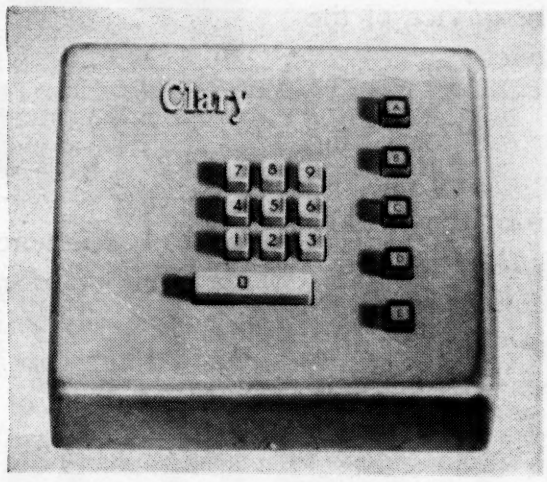
▶ **Stable Film Resistors**—Nichrome film resistors which remain stable to within 1% of rated values over a 90-day storage period are being fabricated as part of a thin-film component effort at Douglas Aircraft. Ohms per square values of the films range from 250 to 50,000 ohms. Typical power dissipation is 2.5 watts. Titanium dioxide–aluminum capacitors in values up to 0.1 microfarad were also developed by vacuum evaporating and then oxidizing titanium films, evaporating a silicon monoxide dielectric, and finally adding an aluminum second electrode.

▶ **Stepping Up Research**—Accelerated applied research program is getting under way at Kollsman Instrument Corp., a division of Standard Kollsman and manufacturer of astro-guidance systems. One phase of this program will involve application of techniques for generating, modulating and detecting light. This includes integrating devices such as optical masers into specific systems.

▶ **Thin-film Computer Readied**—Feasibility model of a stepping strip computer which will employ thin films to achieve reliability and producibility is expected to be completed in March. Developed under the Army-Navy Instrumentation Program at Douglas Aircraft, the model will have a magnetic domain memory consisting of magnetic strips into which information is stepped for storage. Following companies are participating in the development: Servomechanisms—magnetic domain memory; Litton Industries—logic design; and Varo Mfg.—assembly of thin film techniques.

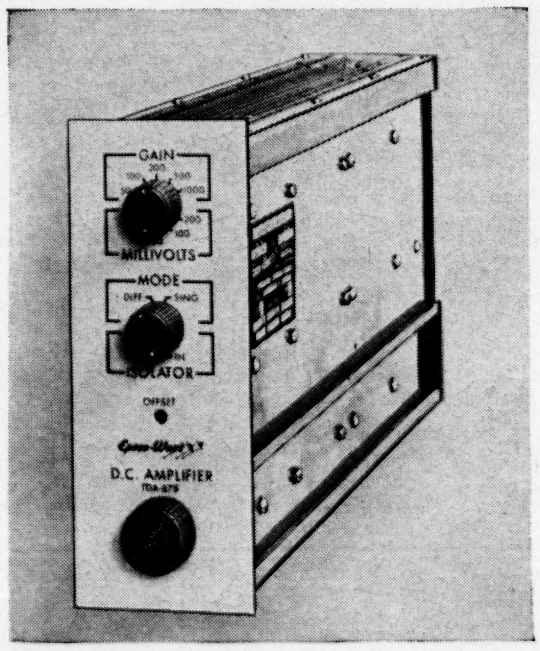
NEW AVIONIC PRODUCTS

• **Direct entry, data input unit** has 10-key keyboard and can accommodate from 5 to 30 control keys. Unit can



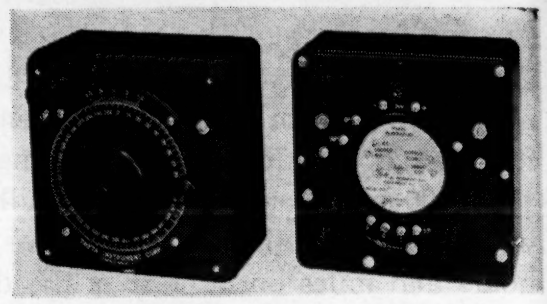
be adapted to variety of computer, checkout or testing systems. Manufacturer: Clary Corp., 408 Junipero St., San Gabriel, Calif.

• **Differential amplifier,** Model TDA-875, a transistorized device for those applications where high common mode rejection, high input impedance and reliability are needed. Front panel control selects between differential and single-ended (potentiometric) modes. Characteristics include 3,000 megohms

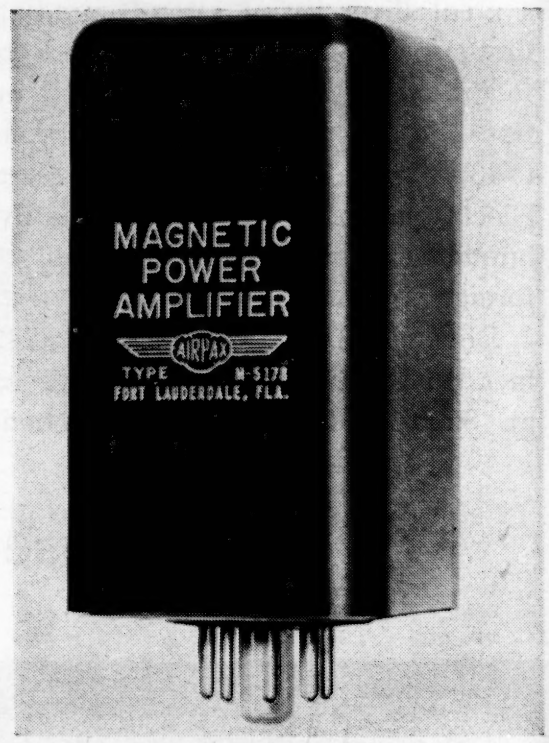


input to output isolation, 100 megohms input impedance, 120 db. common mode rejection, 300 v. common mode level range bandwidths of 5 kc. differential, 150 kc. single-ended. Bulletin 875 with full specifications is available on request from manufacturer: Epsco-West, 240 E. Palais Rd., Anaheim, Calif.

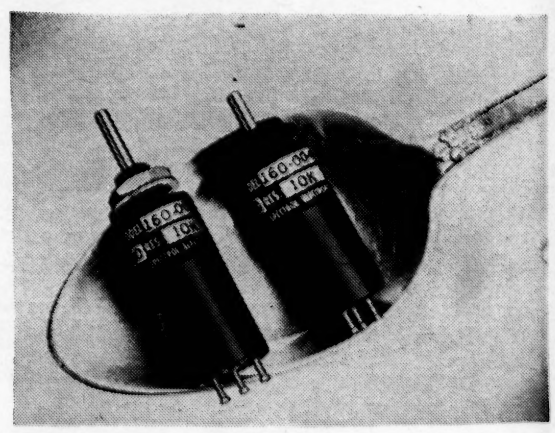
• **Phase generator,** Model PGA, completely solid-state with guaranteed life of 10,000 hr., will drive synchros, choppers, demodulators, generators and motors. Signals can be phase shifted through 360 deg. without amplitude variations. Generator output is zero to



180., input 115 v., phase error, 30 min. Price is $425 with delivery from stock. Manufacturer: Theta Instrument Corp., 520 Victor St., Saddle Brook, N. J.



• **Magnetic servo amplifiers** will drive instrument-type two-phase servo motors controlling current to both phases thus reducing equipment standby power requirements. Input is d.c. polarity reversible, output a.c. phase reversible. Total power gain in conjunction with company's preamp is 8 million. Price is $93 each in quantities of 1-6 with three to four week delivery. Manufacturer: Airpax Electronics Inc., Ft. Lauderdale, Fla.



• **Miniature 10-turn** potentiometer, Model 160, available in resistance ranges up to 200,000 ohms in standard linearity tolerances to ±0.5% or with special tolerances to ±0.05%. Operating temperature ranges are −55C to 125C, power rating is 2.5 watts (40C ambient). Manufacturer: Spectrol Electronics Corp., 1704 So. Del Mar Ave., San Gabriel, Calif.

Radar Designed to Control Lunar Landings

New York—Raytheon Co. has worked out a preliminary design for a radar system that could take command of a Centaur or Nova space vehicle during the last 10 min. of its flight and give accurate commands to its retrorockets so the vehicle could make a soft landing on the moon.

In a report presented at the Lunar Flight Symposium of the American Astronautical Society, Arthur Barabush of Raytheon's Missile Systems Division delineated Raytheon's initial design which would go into operation after the vehicle had approached the surface of the moon and had been turned so that its retrorockets faced the moon.

The Raytheon system would work in conjunction with an infrared or optical horizon scanner which would control the verticality of the vehicle.

According to Barabush, sensors that would enable a vehicle to make a soft landing on the moon would have to be capable of determining, continuously and accurately, three quantities: vehicle altitude vertical velocity (vector) and lateral velocity (vector).

With a system that assumes command of the vehicle at 60,000 ft. above the lunar surface at a vertical velocity of 7,000 mph. ± 700 mph. and a lateral velocity of zero, ± 700 mph., altitude determination would have to be accurate to within 1% and velocity information would have to be within 7 mph. of actual velocity when the space vehicle is slowed to near-zero velocities.

Should the system be designed to take over at an altitude of 30,000 ft. above the moon with lateral and vertical velocities of zero, ± 200 mph., altitude accuracy must be within 5% and velocity accuracy within 1-2 mph. at near-zero velocities.

Raytheon's design would use a closed-loop radar system to determine the three necessary quantities. Barabush said radar is preferable to optical-inertial or infrared optical horizon scanners for this purpose because the last two systems, being open-loop, use information obtained several lunar radii away from the moon to control the landing and thus could be subject to large velocity errors if the moon surface altitude estimate was even slightly off. As an example, Barabush showed that if the estimated moon-surface altitude was only 100 ft. off, a velocity error of 22 mph. could result.

The Raytheon radar sensor would make use of the scattering properties of natural surfaces. Radar energy returning from a rough surface will be frequency shifted (doppler effect) by the relative velocity between the transmitter and the individual scatterer. Scattering will allow the velocity data to be gathered by radar that is beamed at an oblique angle to the surface of the moon. Therefore, information from three noncoplanar radar beams aimed at the lunar surface like legs of a tripod, together with a vertical reference system such as an infrared horizon scanner, could determine both lateral and vertical velocity.

In this tripod arrangement, one of the beams would also be used for altitude measurement.

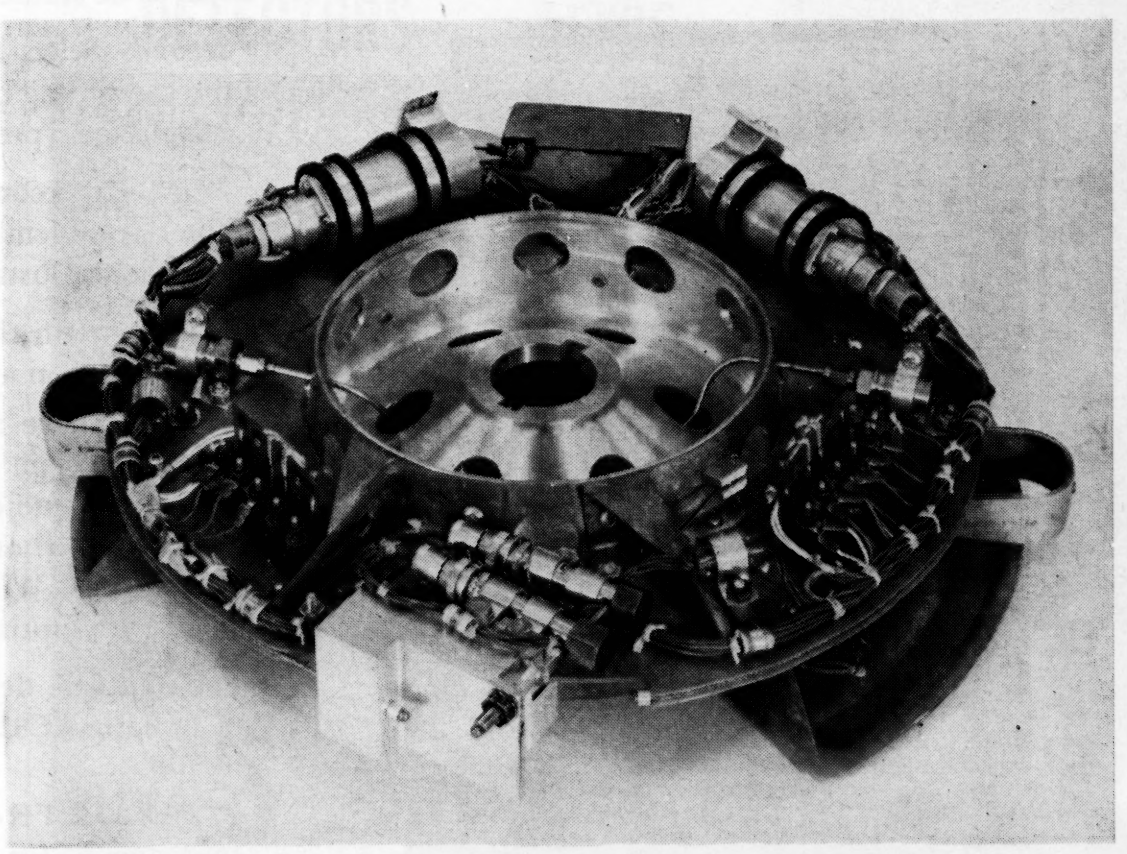
Barabush maintained that the radar could be instrumented with a CW system (transmitter continuously sending and receiver continuously picking up the scattered doppler-shifted signal). Aperture limitations in the Raytheon design prevented the use of a two-aperture-per-radar-beam system (straight CW needs separate transmitter and receiver antennas) so Barabush recommended an FM-CW system having a design complexity only slightly greater than a straight CW system and requiring only one antenna per radar beam. At extremely low altitudes, he said, the system would switch to straight CW to eliminate false nulls which can occur in FM-CW equipment.

The signal return is so large at about 150-ft. altitude that dual antennas for straight CW operation would not be necessary.

The specifications of Raytheon's preliminary design would produce a 35 kmc. lunar landing radar with a weight of 50 lb. that could be packed, including antennas, into 3 cu. ft. of space. Power requirements for the system would be 300 w. and its velocity and altitude accuracy, after the radar took over at 60,000 ft. lunar altitude, would be 1.5% and 5% respectively. At low velocities and altitudes near touchdown, bias errors would be the dominant factors. For this equipment, the maximum bias error would be 1 mph. velocity and 25-ft. altitude.

According to Barabush, one possibly critical factor in the design of a lunar landing radar is the calculation of the exact radar reflection characteristics of the moon's surface.

Experimental evidence gained using



Weight Protects Tiros Satellite

Third stage of Tiros II booster vehicle, placed in orbit Nov. 23, 1960, was prevented from bumping its satellite payload immediately after separation by light-colored L-shaped weight in foreground of photo. Weight, part of a system developed by Douglas Aircraft Co. for the Delta launch vehicle, is a 1.5 lb. aluminum block, attached to a 40 in. nylon cable. At time of payload separation, the weight is released and unwinds, despinning and imbalancing the third stage so that it tumbles away from the satellite.

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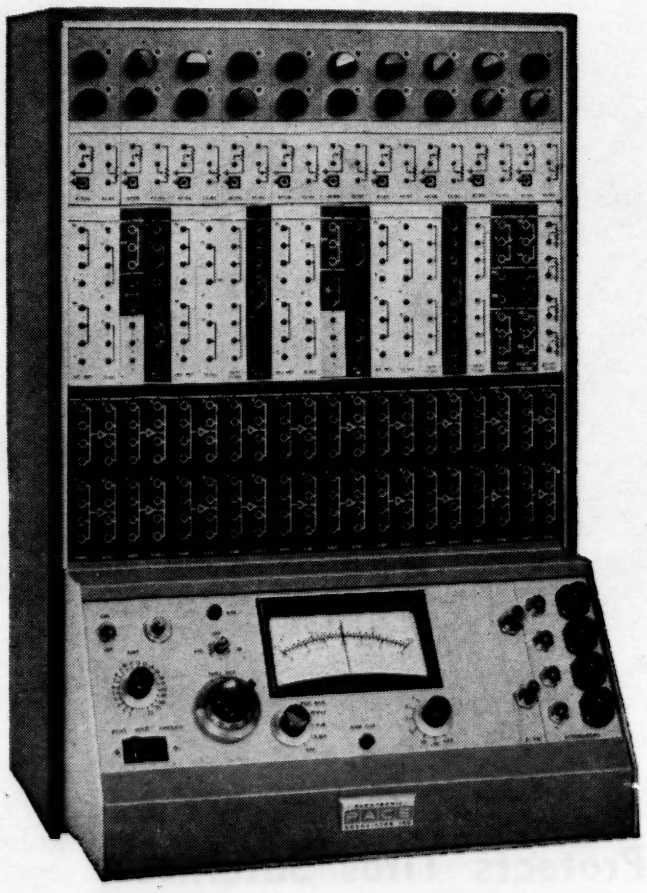

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a wide radio spectrum, 150 mc. to 3 kmc., shows that actual reflectivity is 6 db. or greater than that indicated by computations based on an assumption that the moon's surface is an isotropic scatterer. This, says Barabush, would indicate that some radar is not scattered by the lunar surface. Other experiments with earth areas that would seem to have the same characteristics as the lunar surface (dry deserts) have led some authorities to estimate that at a beam incidence angle of 70 deg., a −17 to −30 db. reflection coefficient would result. Barabush thinks that 20 db. is a reasonable estimate.

Another factor that could produce error in the system and which Barabush thinks will not be known until a vehicle actually arrives at the moon, is the possibility of a thick layer of dust on the moon which, if raised by the blast from the retrorockets, could scatter the radar energy sufficiently to render the system useless.

Ionized sheaths around the moon would not bother the 35 kmc. radar, Barabush concluded, because the moon's atmosphere is so thin, and the effect of ionized gases in exhaust plumes of the retro and lateral control rockets can be minimized by shielding and placement of the rockets.

As an extra dividend from the 50-lb. landing package, Barabush said its instruments could be used to send information back to earth after the landing is made.

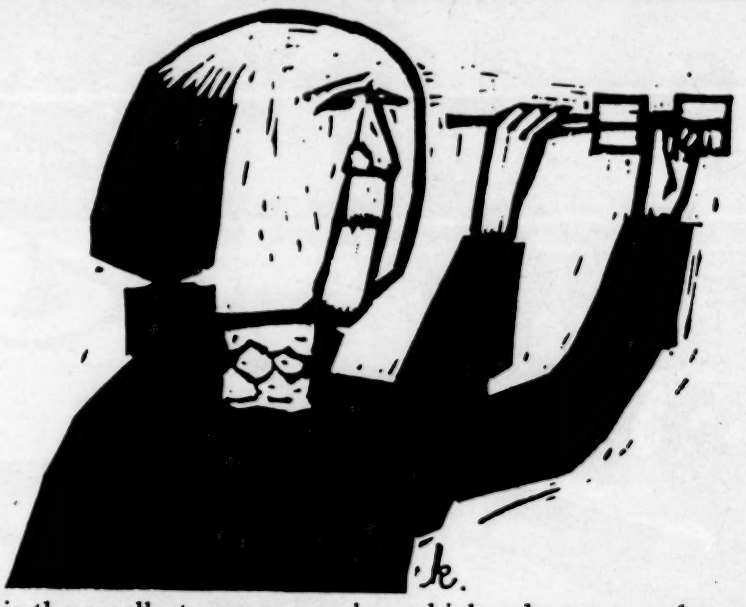
Capsule Spinning May Hamper Astronauts

New York—Spinning a space capsule to create artificial gravity may reduce an astronaut's ability to function properly because of the effect of angular acceleration forces on the semicircular canals of the inner ear.

Dr. Ashton Graybiel, director of research at the Naval School of Aviation Medicine, told members of the American Astronautical Society here that men who were subjected to several days of rotation in a centrifuge equipped for habitation sometimes experienced extreme discomfort at relatively low rpms. (less than those which are necessary to produce 1g).

Even normal head movements, particularly toward or away from the center of rotation, created angular acceleration which caused the semicircular canals in the inner ear to send bizarre signals to the brain. This resulted in discomfort and/or sickness for many of the test subjects. At 1 rpm. little or no trouble was encountered by any of the test subjects beyond that of having to adapt to some visual phenomena. (Depending on which way the test sub-

PROBLEMATICAL RECREATIONS 48



What is the smallest square number which, when squared results in the largest possible succession of equal digits? —*Ladies' Diary, 1810*

Our Monroe division's Monrobot XI computer accepts information in every kind of computer language, discloses results of payroll computations, inventory control, linear programming, probability analysis, etc. any way you want to read them. For a booklet, write: Monroe, 555 Mitchell Street, Orange, New Jersey.

ANSWER TO LAST WEEK'S PROBLEM: An infinite series need not be the means of solution; a trivial means exists. 300 miles.

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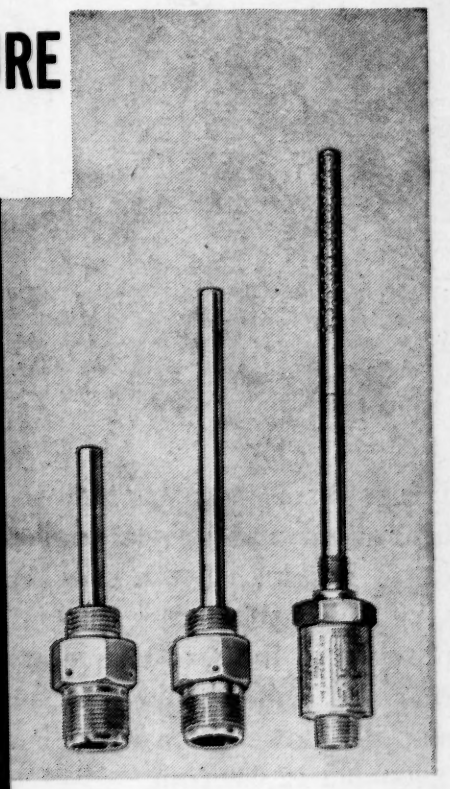

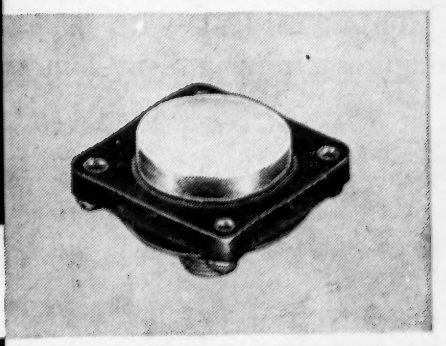

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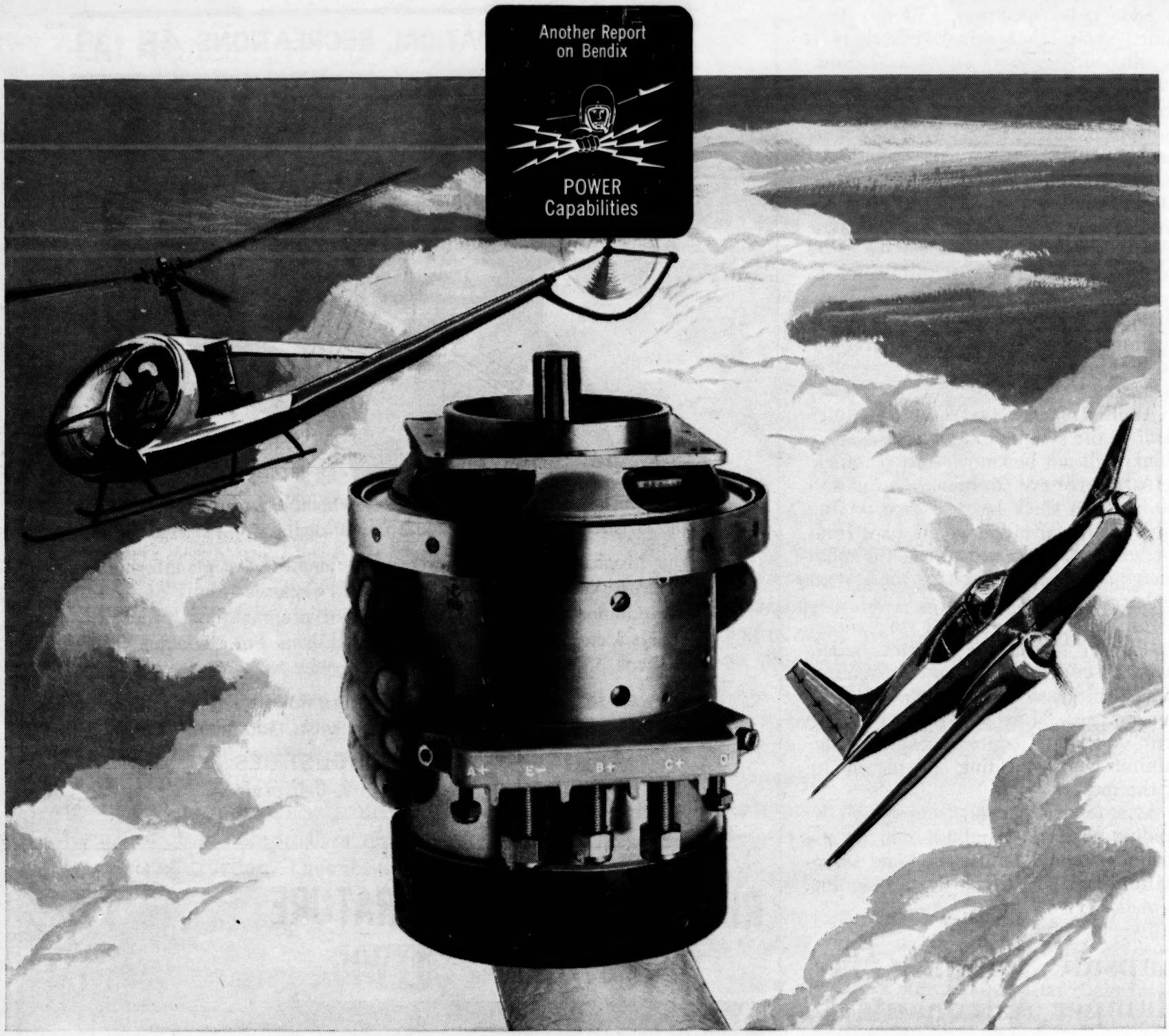

"MIDGET WITH A PUNCH"!

Bendix 16-lb. DC Starter Generator

Designed specifically to help the new lightweight gas-turbine engines get off to a quick start is the Bendix® type 30B56 DC Starter Generator. It provides 10 lb. ft. of torque at 3,000 rpm and will produce 30 volt/100 amp. DC power when driven between 7,000 and 12,000 rpm.

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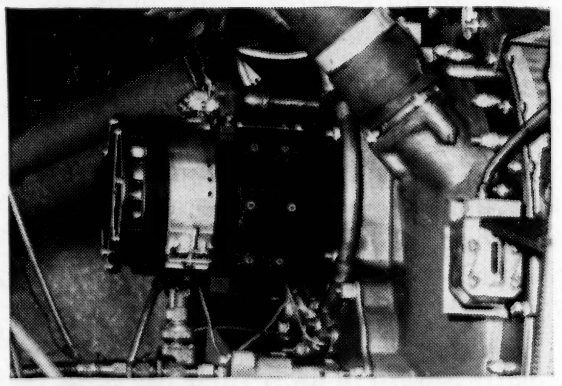
If your needs are to start small gas turbines rated around 250 hp with a DC source, specify the Bendix type 30B56 and get 3 KW DC power, too. See us for details as related to your specific application.



Its small size makes the 30B56 Starter Generator ideal for use on the new small gas-turbine engines.

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jects looked, objects at first appeared to move up or down.)

At 1.71 rpm. the subjects experienced a slight amount of sweating, nausea, sleepiness, headache and difficulty in walking.

The symptoms disappeared after a day or so but reappeared briefly when the rotation was stopped.

Decay at 10 rpm.

At 5.44 rpm. two of the subjects were able to adapt to more severe symptoms of the kind noted above but one subject who had no previous record of motion sickness was completely incapacitated. Spinning at 10 rpm. brought on deterioration of most of the test subjects' ability to perform normal functions because of the onset of severe symptoms first noted in the tests at 1 rpm.

The only man who experienced none of the symptoms and was comfortable at all speeds had previously lost the function of his inner ears.

Graybiel, noting this, said that one possibility for relief of the symptoms in astronauts would be artificial deadening of the inner ear responses as is done for sufferers of Minieres disease (vertigo caused by malfunction of the semi-circular canals). At present this is done with dosages of streptomycin, but Graybiel said that other means would have to be explored for healthy astronauts.

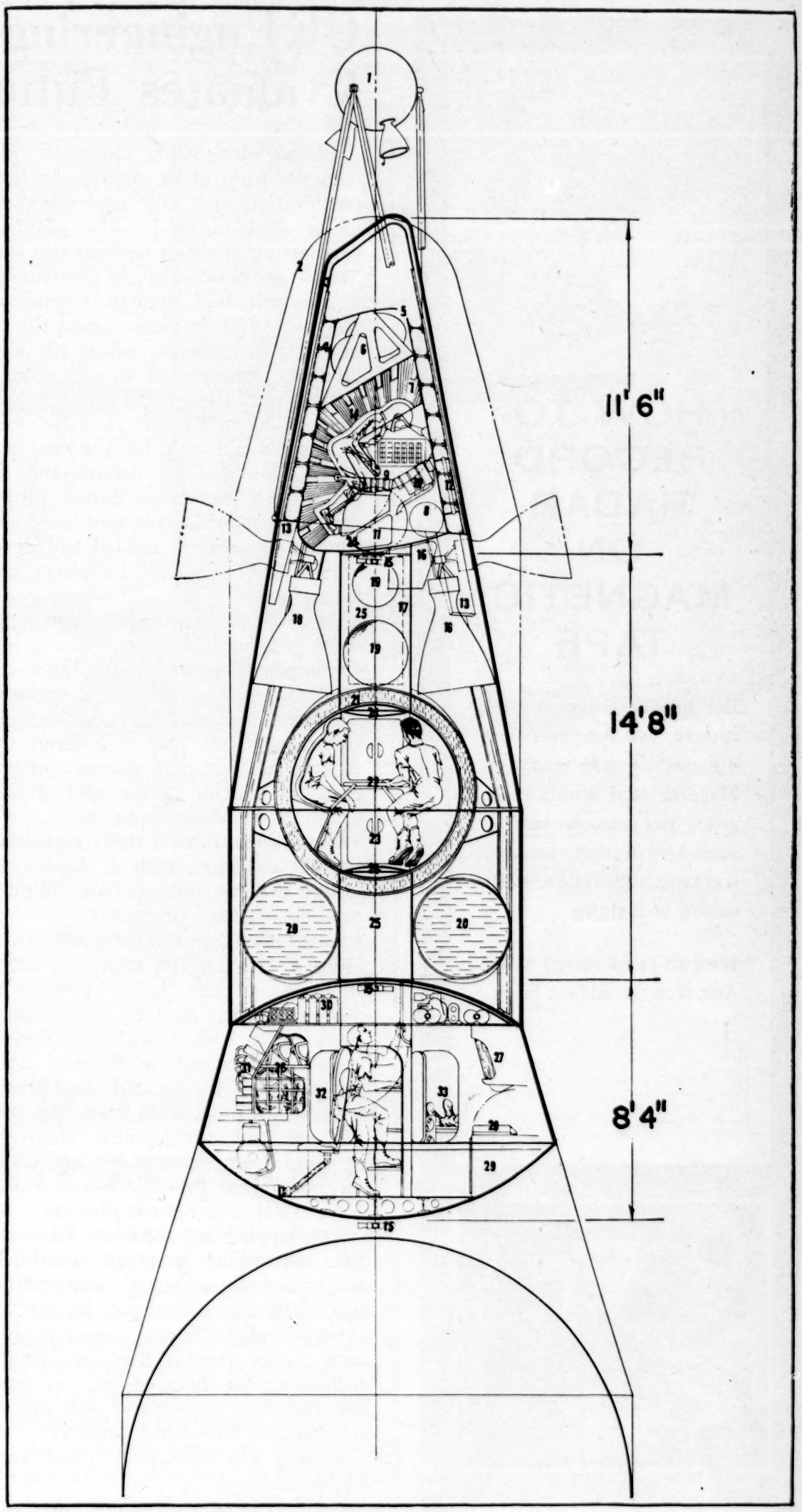
AAS Forum Will Weigh U. S. Space Efforts

Dallas, Tex.—Appraisal of U. S. space efforts will be made by a forum consisting of Lt. Gen. Bernard A. Schriever, Dr. Wernher von Braun, Dr. Fred L. Whipple and Rep. Olin Teague (D.-Tex.) during a three-day program sponsored by the American Astronautical Society in Dallas, Jan. 16-18.

Talks by other national authorities will also highlight the sessions, during which about 60 reports will be presented covering space technology. There also will be static exhibits by more than a dozen manufacturers of equipment for astronauts and space vehicles.

Space vehicles and their costs, space law, astrodynamics, cosmology, solar systems applications, communications, navigation and guidance, bioastronautics, re-entry and recovery and social and political aspects of space operations are among subjects expected to be covered during the meeting.

Presentation of two awards is also on the schedule—the AAS space flight award, acknowledging special astronautics achievements and the society's Melbourne W. Boynton Award, recognizing contributions to astronautics in medical research.



Grumman Proposes Manned Lunar Spacecraft

Grumman proposal for manned lunar spacecraft capable of Apollo-type missions shows maximum use of ablative materials, structure, equipment and propellants to reduce weight of direct radiation shielding needed to protect the crew. In this design, one of several studied by the company's Space Sciences Group as a prelude to its Apollo proposal, a hazard compartment is provided inside the double-walled spherical tank (21) containing liquid oxygen. Grumman studies indicate that adequate crew shielding against normal radiation would be provided by a layer of carbon of sufficient thickness to weigh 20 psf. (AW Jan. 2, p. 24).

HOW TO RECORD RADAR ON MAGNETIC TAPE

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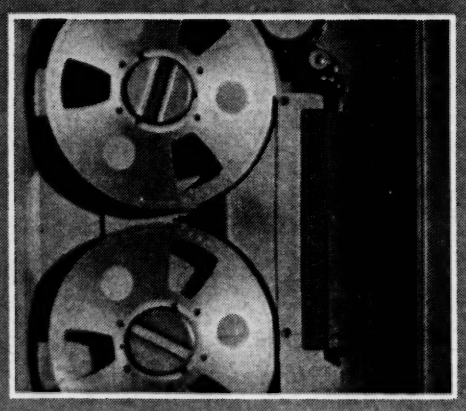

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GE Engineering Group Studies And Evaluates Future Space Concepts

Philadelphia—Wide range of space concepts from earth satellites to lunar colonization and solar exploration are under study here by the advanced engineering group of General Electric's Missile and Space Vehicle Department.

This advanced systems engineering team of 160 consists essentially of practical theoreticians whose job is to establish concepts of future systems, then assess the practicality of their ideas. General Electric feels the team is valuable not only for the sales produced, but also for determining the most likely trends in future project personnel requirements, outlining subcontracting support needed and developing new scientific disciplines and technologies.

Most of the advanced engineering effort goes into:

• **Company-generated conceptions,** currently in solar probes, large payloads, space terminals and lunar colonization. Object is to set the stage about two years in advance of a government program for systems designs and identification of technical requirements.

• **Government-funded study** and development contracts, such as Apollo, advanced re-entry concepts (Arc), Nimbus components and Advent.

• **Anticipated government contracts,** in order to demonstrate company understanding of such future projects as reconnaissance, weather, communications and defensive satellites. Specific system studies include National Aeronautics and Space Administration's launch-from-orbit. Solo, orbiting geophysical and astronomical observatories, and Prospector and Voyager planetary packages, and Air Force Smart, Vela Hotel, and Slomar projects.

Overlapping requirements for scientific and military programs already defined, and those being examined for feasibility, are considered in the advanced studies. Among common problems under consideration are orbital techniques for checking out, maintaining, repairing, staging and maneuvering manned and unmanned satellites.

Project scientists have these areas under study:

• **Solar exploration,** seen as involving a 250-lb. probe which will investigate the environment to within 9.3 million mi. of the sun. Objective would be a study of solar flares and fields, which could result in a foundation for a meteorological forecasting system of the sun's weather. Missile and Space Vehicle Department is studying the component developments required for a solar probe which could investigate the total spectrum between the earth and sun. Payload currently is envisioned as a growth of the NERV package.

• **Large payloads,** basically the approach considering one-stage flights from earth to planets. This approach is opposite that of launching planetary vehicles from an earth orbit and envisions vehicles 10 times the size of Nova able to put up payloads the size of a large ocean liner such as the Queen Mary. Group is attempting to separate fact from fantasy in determining the largest reasonable size for chemically fueled launch vehicles. From chemical fuels, the group will advance to studies of nuclear boosters and ion drives.

Included in this study are considerations of how use can be made of materials of spent propulsion systems, which will be enormous, extremely rugged, but usually in the wrong shape for immediate use in the mission.

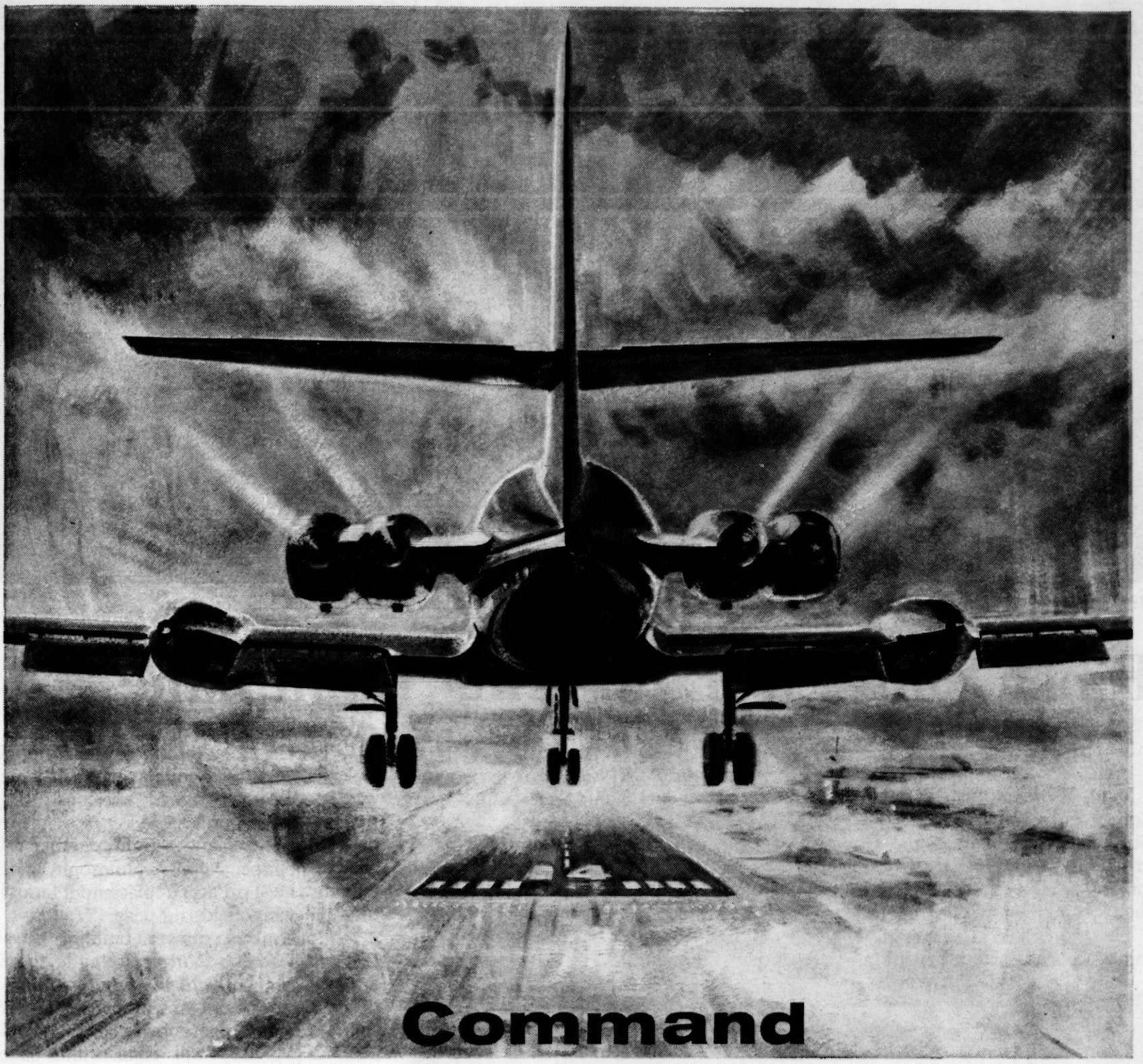
• **Space terminals,** concerned with the general conception of requirements for a large space station which would function as a communications satellite in a stationary orbit. Terminal would be the working area for a 40-man crew and would be serviced routinely from earth. The studies are aimed at determining how far in size and payload function it is reasonable to go.

• **Lunar colonization,** to determine requirements for food, oxygen, power and return to earth for a 10-man crew, which would lay the framework for a means of exploring and exploiting the moon and planets.

GE feels that colonization of the moon is no longer fantasy because of promising concepts in structural design which incorporate use of a spent second-stage casing to attenuate landing shock. This technique would eliminate a requirement for landing rockets.

Lunar landing vehicles to establish the colonies would be configured as intersecting sphere modules, which would be assembled on the moon to form a number of compact shelters for housing, laboratories, shops, power stations, environmental generating plants, storage and recreation facilities.

Using the present dollar value, it would require 200 Saturn launches, costing $850 million, to land the crew and 500,000 lb. of essential materials for the moon colonists. Crew would consist of a physician-dentist, mechanical engineer, electrical-electronics engineer, electrical-mechanical engineer, astronautical engineer, chemist, geophysicist, space scientist, machinist-mechanic and a miscellaneous crewman with a general knowledge of all disciplines.



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The SP-40 customer is supported by Sperry's world-wide sales-service organization, which includes trained engineers, instructors and technicians. Write or telephone for detailed information.

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PIPER Cherokee four-place lightplane has swept tail and is powered by 160-hp. Lycoming O-320-B four cylinder engine.

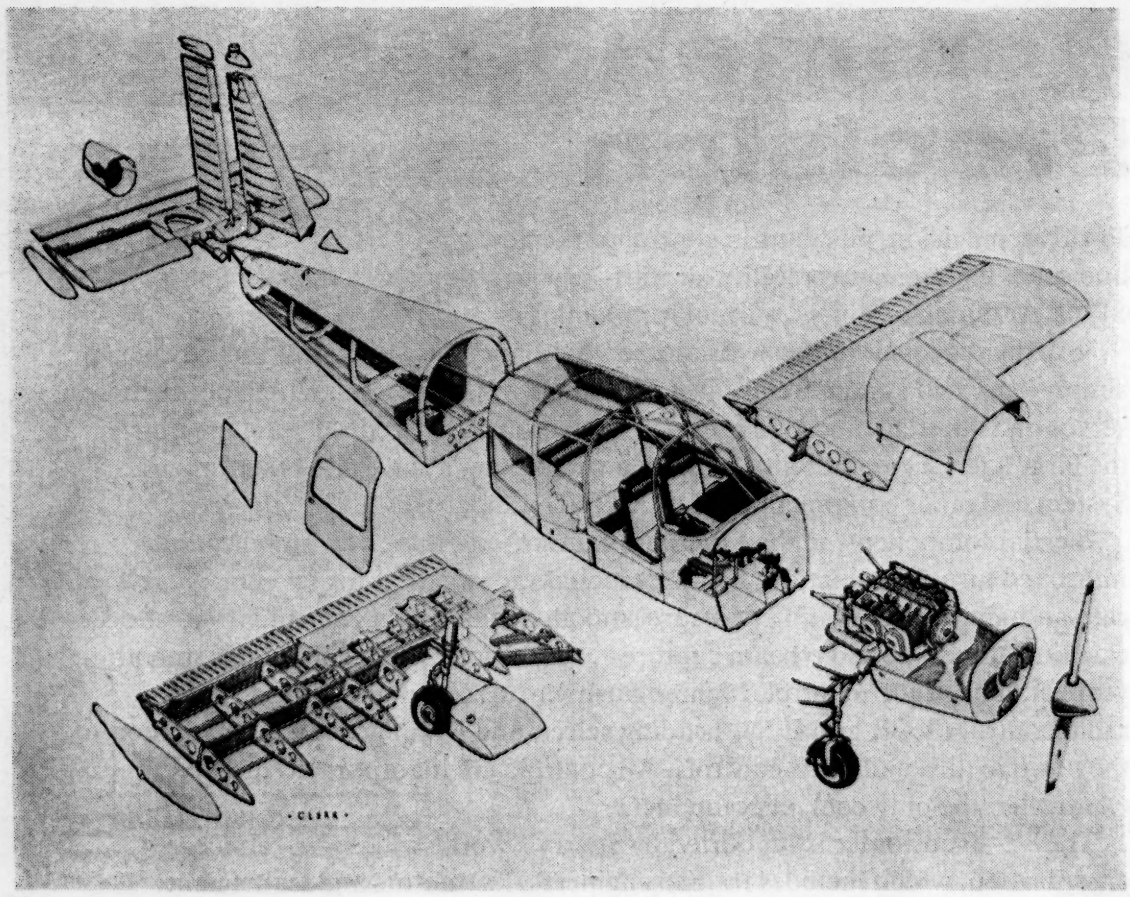
Piper Shifts to Low Wing Lightplane

By Herbert J. Coleman

Vero Beach, Fla.—Piper Aircraft Corp.'s entry into the low wing, all-metal lightplane market—the Cherokee—is being built here with design and construction methods aimed at simplicity combined with strength.

The Cherokee, priced at $9,995, points up the swing toward all-metal planes. Mooney Aircraft Co. also is moving into that area with its new all-metal Mark 21 four-placer which costs $15,995.

Piper's latest entry into this highly competitive field was keynoted with rollout of the first production model here yesterday, an event timed with the 80th birthday of the company's president, William T. Piper.



SIMPLICITY of design and construction is pointed up in this exploded view of the Piper Cherokee. Propeller is 60 in. Sensenich which may be changed to 61 or 62 in. size.

Rollout signified start of production in Piper's new $1.3 million plant which was specifically designed for construction of the Cherokee (AW Nov. 14, p. 128). The plane signifies a major change in Piper's design philosophy by moving the Tri-Pacer replacement into the low wing field.

Although Piper now is building the two-place Colt sportplane and the Super Cub, both high wing aircraft, future development—including the projected Piper Papoose two-placer (AW Dec. 26, p. 13)—will concentrate on low wings, primarily as a ground safety and handling factor, according to Howard Piper, vice president-research and development.

The company feels that low wing aircraft are more practical, and safer, for ground handling in gusty and high wind conditions. High wings, Piper claims, have a tendency to capsize in these conditions. Another low wing advantage is placement of gear, giving a wider tread and thus easier taxiing and turn capability.

Cherokee keynotes another major switch in the all-metal approach, a departure from the Pacer's fabric and metal tubing fuselage. The reason, Howard Piper explained, is simple—the company can build the Cherokee out of aluminum just as cheaply as it can from fabric, and metal is a better factor in sales because of its appearance and long life.

Unlike Piper's other new model, the Colt—which uses many Pacer compo-

nents—the Cherokee is an all-new aircraft that already has generated considerable interest in stops at airports between Vero Beach and Piper's Lock Haven, Pa. plant.

The airplane has a slight resemblance to the Piper Comanche, engendered by the cabin shape and the swept tail. Wings are thick and have a 7 deg. dihedral for a high stability factor, particularly in yaw and roll moments.

Chief of the design team is Fred E. Weick, director of Piper's Vero Beach Development Center, a man with a broad design background that includes design of the Ercoupe and aerodynamic work with National Advisory Committee for Aeronautics and Hamilton Standard. He also pioneered development of the tricycle landing gear.

Weick's choice of a swept tail on the Cherokee is a reflection of the introduction of the civil jet: "The airplane looks better, but we could have built the airplane cheaper using a straight tail." This factor, along with increased emphasis on exterior color and cabin design, is gaining increased importance in the business flying field. Cessna also sweeps tail surfaces, finding it a selling point.

The Cherokee came into being in 1956, when Weick headed areodynamic research, concentrating on agricultural planes, at Texas A&M. He was invited by Piper to take over its newly formed Development Center and given the Cherokee general specifications by Howard Piper.

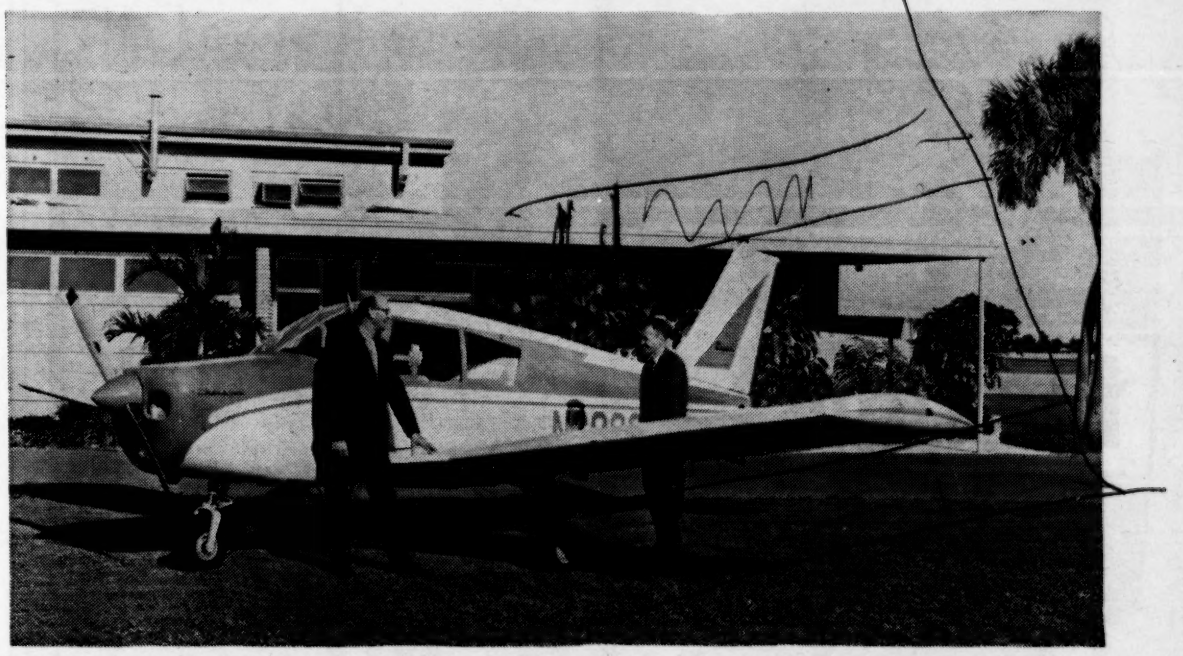
From Weick's first office at Vero Beach, in the municipal hangar, the Development Center has moved into new quarters near the main production plant. About 300 persons are now employed at Vero Beach by Piper, 50 on the Center's staff.

Design and construction simplicity has been the criteria in the Cherokee project from the start, and current production practices show that Weick's team largely achieved this aim. Program has been under direct supervision of Karl H. Bergey, assistant to Weick.

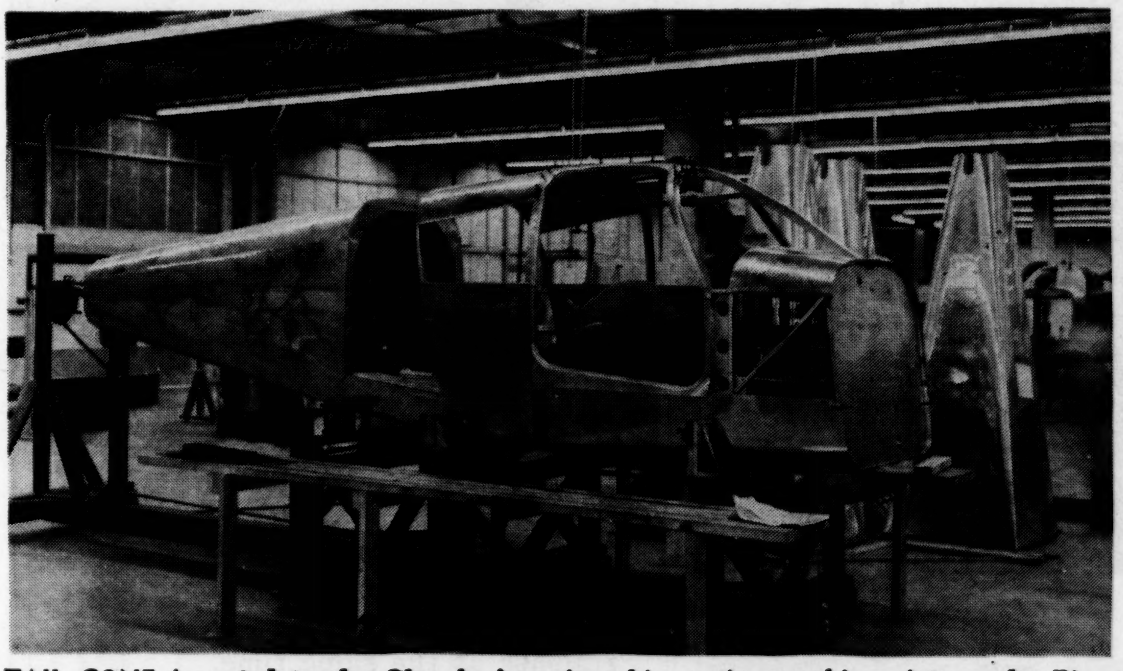
The Cherokee, which will reach a five-a-day production rate by next fall, is being built in a 123,400 sq. ft. plant which can be expanded if necessary without disturbing the production line, according to E. Herbert Andersen, Jr., assistant to plant manager M. L. Blume.

In effect, the Cherokee has been in production, Andersen noted, since last September, when fabrication of parts for Cherokee Lot No. 1 started. Actual production schedule calls for completion of the first 25 airplanes in a 10-week period starting Feb. 2 and ending Apr. 4. Second lot will be 75 airplanes, reaching a five-a-day rate by next fall.

Most of Piper's Cherokee work force is trained by key personnel who run

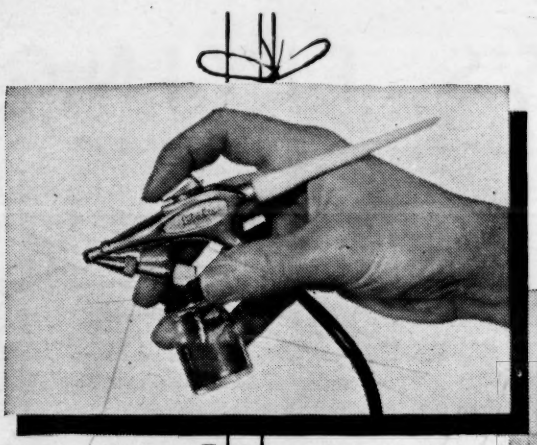


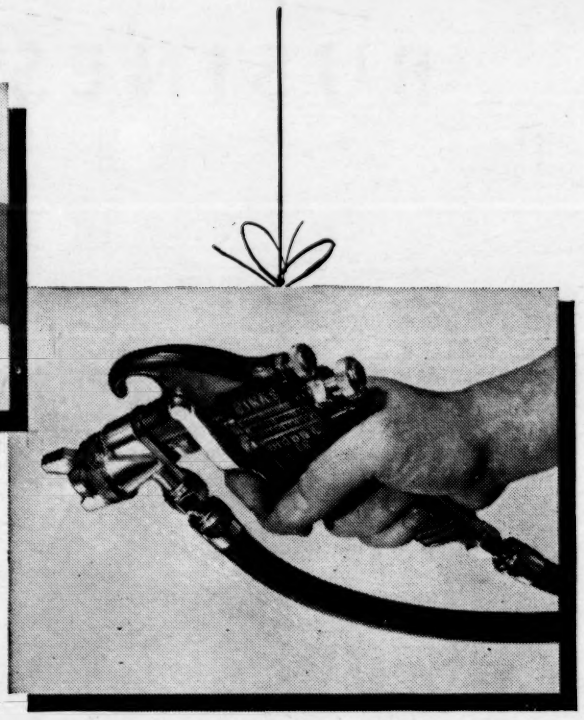
CHIEF of Piper's Development Center at Vero Beach, Fla., is Fred E. Weick, left, shown by new Cherokee with Karl H. Bergey, assistant chief engineer in charge of Cherokee design.



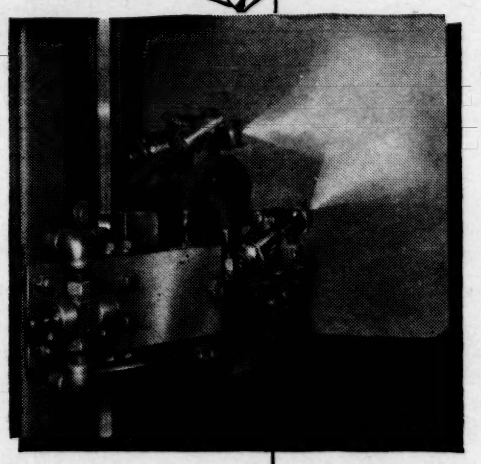
TAIL CONE is mated to the Cherokee's main cabin section at this point on the Piper production line at Vero Beach. Cabin is built in two sections and mated on a rotating jig.

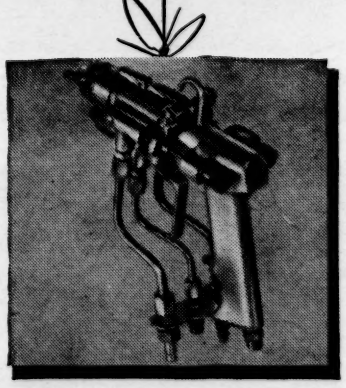
LIGHT BEACON is installed on Cherokee tail as the first production model starts down the production line toward the engine buildup section. Track guides the airplane dolly.





the right spray gun can make a big difference





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an on-the-job training program. All tools, ties, jigs and templates are being made in the plant tool shop and only larger pieces of metal are being cut in Lock Haven and shipped to Vero Beach.

Plant also includes a Plastics Production Department, headed by Robert Drake, that forms all Cherokee extremities, such as the nose cowl, and tips for wing, stabilator, fin and rudder. Unit also makes hoppers for the Pawnee agricultural plane.

Cherokee production follows accepted aircraft building procedures in that parts are built on a particular schedule for stockpiling at strategic positions on the production line at certain times. First station on the double-U line is the stock room and parts forming area, where Cherokee parts simplicity is shown first hand.

Cherokee uses 1,200 parts, compared with 1,600 for the Tri-Pacer. Another example of savings in this area: Cherokee aileron has 10 parts, to 36 for the Comanche PA-24; the Comanche uses 3,714 rivets to 1,785 for the Cherokee.

The emphasis on parts reduction has an effect on other phases of production control. Paperwork, such as plant travelers for parts orders, and labor costs, are cut appreciably.

Vertical tail is an excellent example of this stress on building Cherokee components out of as few parts as possible, for obvious savings in cost and weight. Tail is bent to shape, beaded for strength (as is the stabilator) and tied to a brace which then is attached to a fitting on the main fuselage.

Tail cone, another riveted section, is made here in a simplified jig operation, and then sent to the assembly section for mating at the main second station, a side-by-side operation in which crews work on the subcabin and main cabin. When completed, these sections are mated on a single dolly which then moves to the next station for tail cone mating.

Turning down the main production line, and guided by a track, the airplane gets its nose section, wiring and instrumentation. Wiring reflects another facet in the drive for simplicity in that all wires lead off a single harness. Instruments are installed singly because a packaged panel could be knocked off calibration by riveting machine vibrations, Weick explained.

When the horizontal and vertical tail is mounted, the plane moves ahead to the engine mount section when the 160-hp. Lycoming O-320-B four-cylinder dual ignition powerplant is installed.

Engine mounting, tied to the firewall, also serves as support for the oleopneumatic nose gear and a top tube is hooked to a main brace which separates the pilot's windshield and helps absorb

Piper PA-28 Cherokee

Specifications
(160-hp. Lycoming O-320-B engine)

Gross weight (lb.)	2,200
Empty weight (std.) (lb.)	1,195
Useful load (std.) (lb.)	1,005
Empty weight (Auto Flite) (lb.)	1,235
Useful load (Auto Flite) (lb.)	965
Wing span (ft.)	30
Wing area (sq. ft.)	160
Length (ft.)	23.3
Height (ft.)	7.3
Propeller diameter (max. in.)	74
Power loading (lb./hp.)	13.8
Wing loading (psf.)	13.8
Baggage capacity (lb.)	100
Fuel capacity, (std.) (gal.)	36
Fuel capacity, with reserve (gal.)	50
Tire pressure (lb.)	24 main, 18 nose
Wheel base (ft.)	6.2
Wheel tread (ft.)	10
Performance	
Top speed (mph.)	138
Cruising speed (75% power, sea level)	123
Optimum cruising speed (75% power, 7,000 ft. mph.)	132
Stalling speed (flaps down mph.)	56
Takeoff run (ft.)	775
Landing roll (flaps down, ft.)	550
Best rate of climb speed (mph.)	85
Rate of climb (fpm.)	700
Service ceiling (ft.)	15,000
Absolute ceiling (ft.)	17,500
Fuel consumption (gph. 75% power)	9
Cruising range (75% power, sea level, std. fuel)	4 hr., 492 mi.
Optimum cruising range (55% power, 10,000 ft., std. fuel, 6.6 gph.)	5.4 hr., 650 mi.
Cruising range (75% power, sea level, reserve fuel)	5.5 hr., 675 mi.
Optimum cruising range (55% power, 10,000 ft., reserve fuel 6.6 gph.)	7.5 hr., 900 mi.

bending forces. Airplane then swings back up a parallel line for installation of the wing and main gear. Wheels are all the same size, for interchangeability.

Wing, which has a thick chord, is of simplified but rugged construction. Main spar, made of 2024T extruded aluminum by Alcoa, is shipped to Vero Beach for final milling touches and cut-outs in center sections. Spar is 12.5-ft. long and .275-in. thick and connects with a 4-ft. carry-through slab under the pilots' seats. The wing is an NACA 65_2—415 airfoil section and has a 15% thickness ratio.

Weick used an Ercoupe concept in designing the fuel tanks which form an integral part of the wing. They can be easily removed by unscrewing the skin from connecting panels and unfastening the fuel line from the inlet. Cherokee carries 36 gal. in the standard version and this can be increased to 50 gal.

Slotted flaps have three positions of

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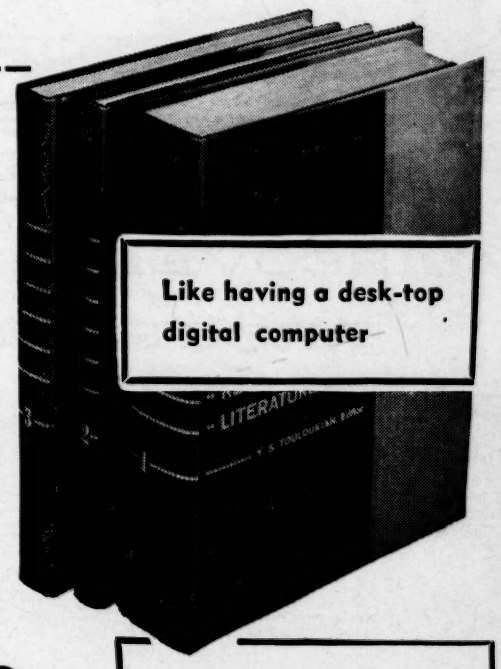

Virtually a desk-top digital computer, here is a comprehensive guide for engineers and scientists requiring information on thermophysical properties of materials.

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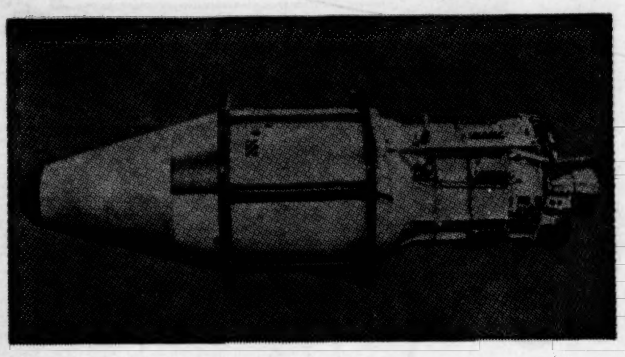

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10, 25 and 40 deg. and cover 14.6 sq. ft. of wing area. They are controlled by a handle between the two pilots. Use of full flaps cuts landing speed 9 mph. at full gross weight of 2,200 lb., from 65 mph. to 56 mph. Empty weight is 1,185 lb.

Seats follow the Piper pattern in the company's other single engine planes and are made at Vero Beach, as is soundproofing. Seat fabrics are made by Findley Industries, as are side panels, mats, headliners and the firewall blanket.

Final production stage is the paint shop, which features a new concept expressly designed for the Vero Beach facility. This involves use of hydraulic ramps to place the Cherokee in various positions for ease and facility in painting. The shop, Andersen said, can handle up to eight airplanes at once in various stages, such as drying and curing. Entire plane is painted as a single unit, rather than painting, say, wing and tail units separately for installation on the production line.

No Ladder

Use of the hydraulic ramps also eliminates the need for ladders and stands. Cherokee is first washed and etched, a coat of primer is sprayed on and base coat of Daytona White added. This drys for 4 hr. and masking and trim is applied. Final cure is made in the shop oven at 120 deg. for 2 hr. and the completed Cherokee then is rolled out onto the ramp for production flight test.

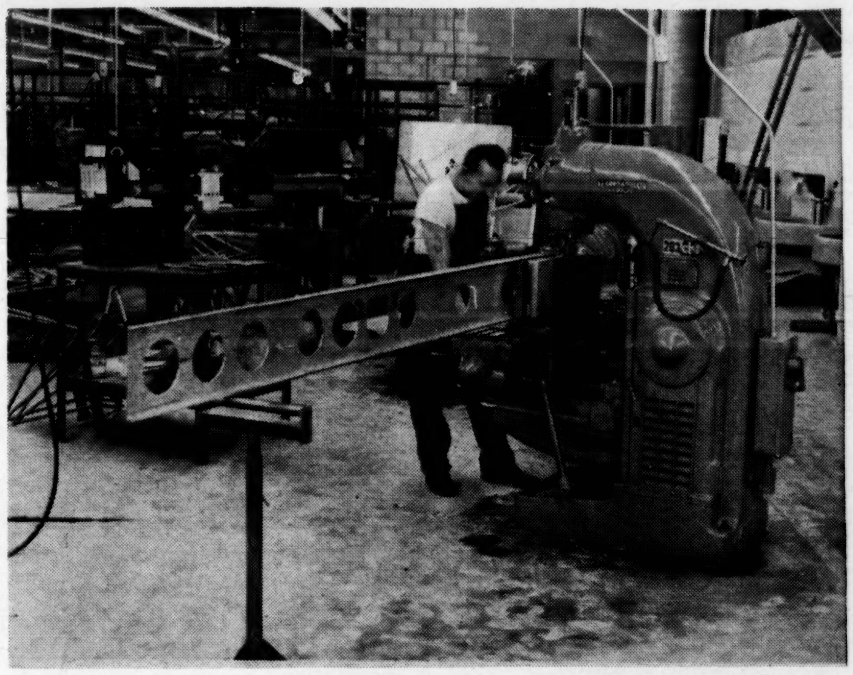
The Cherokee was certificated by Federal Aviation Agency at Ft. Worth, Tex., three months ahead of schedule partly because Weick and Bergey stayed with the airplane to make any possible FAA write-up changes on the spot. No. 1 Cherokee is classed experimental and No. 2 is the prototype, now flying steadily to build up service time.

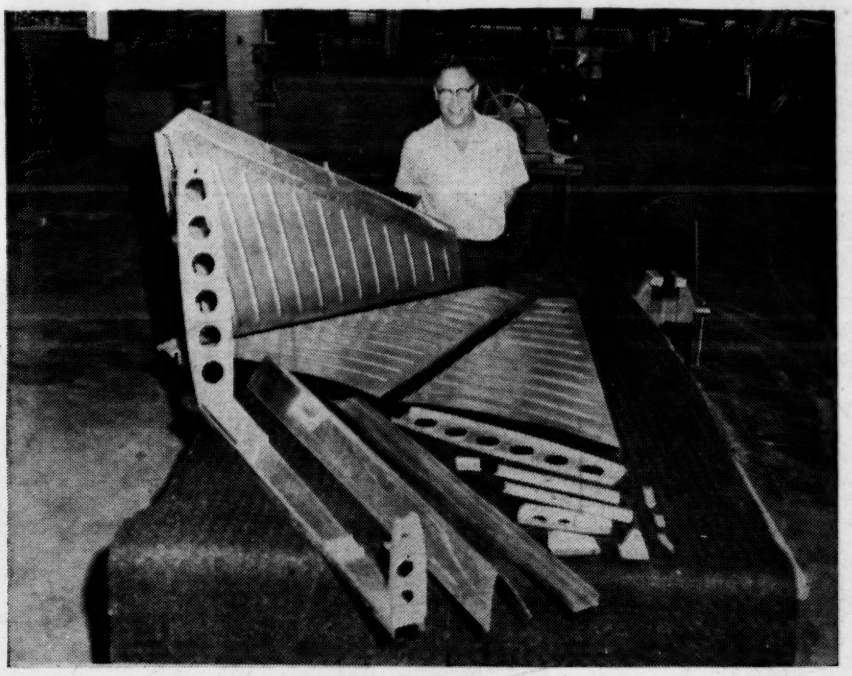
Current projects on the experimental plane include gathering flight data on a 150-hp. engine for eventual approval as a second model. This will call for a lower gross weight figure not yet determined, which possibly will come out of the present 100-lb. baggage capacity. Piper is considering a third model using a 180-hp. engine.

Another project unique in business flying in that FAA is interested in metal fatigue involving lightplanes. Piper will run static tests on the experimental Cherokee at up to 100,000 cycles and make data available to the FAA.

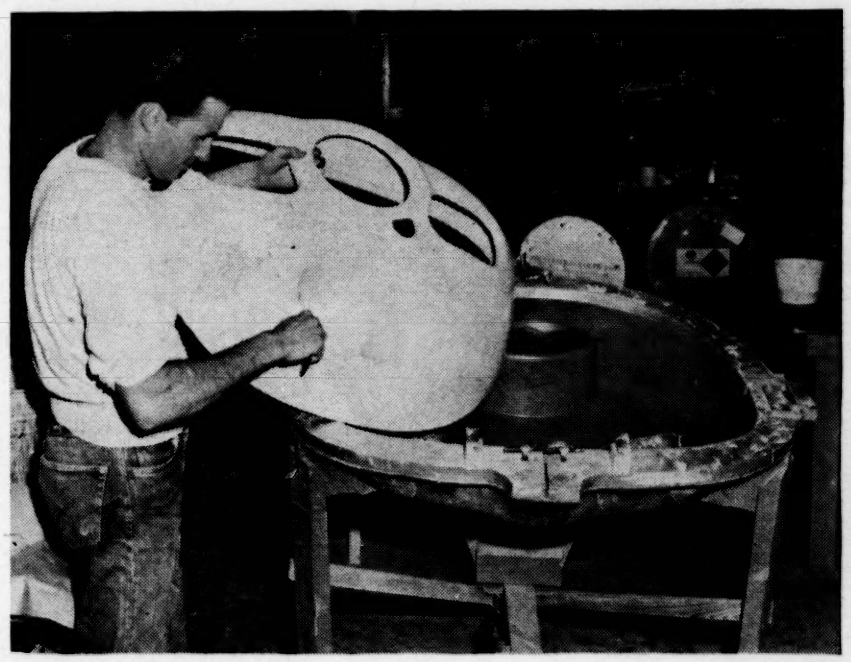
Cherokee prototype has been flown from Vero Beach to Lock Haven and back by Thomas F. Heffner, chief of flight test, who said fuel consumption worked out to 9 gph. at 75% power at 7,500 ft.

Short flight, from Vero Beach to West Palm Beach, was made by this Aviation Week pilot along with Heffner in the right seat. Starting sequence





PLASTICS division fabricates Piper extremities; nose section gets final touches at left. At right is breakdown of the Cherokee stabilator, showing reduction of necessary parts.



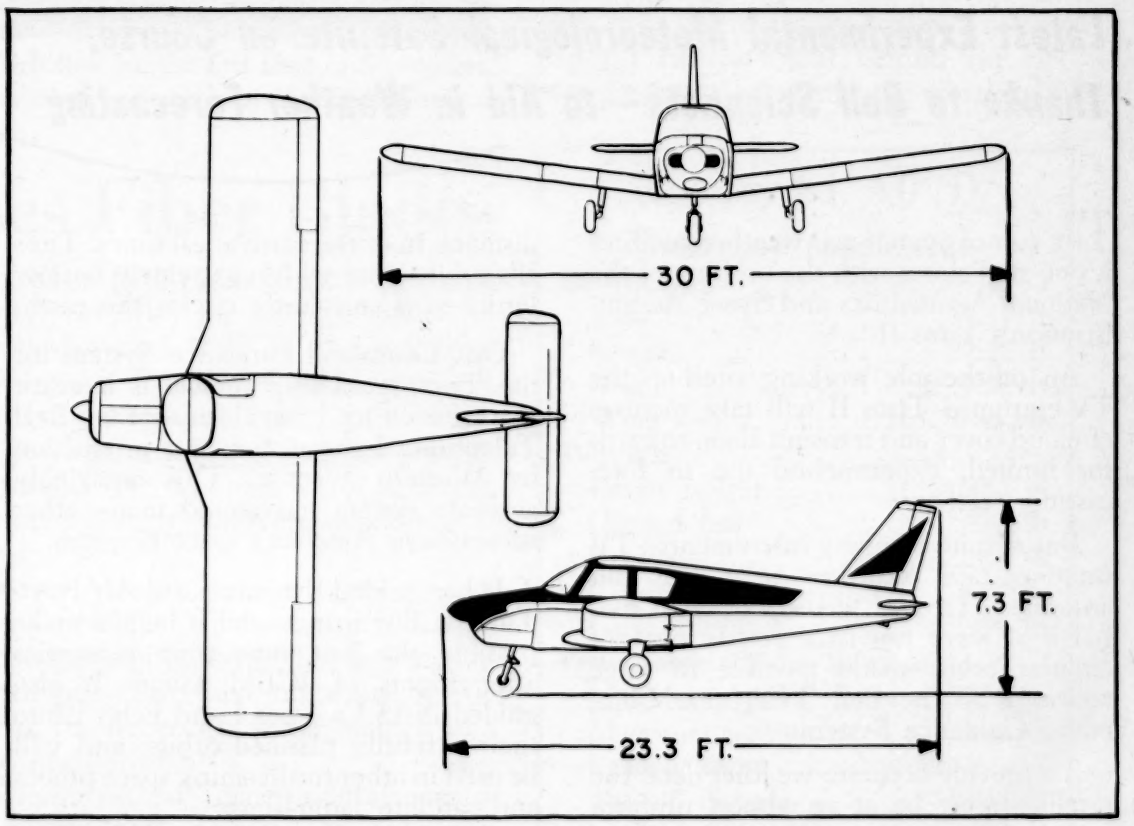
EXTRUDED aluminum spar for Piper Cherokee (left) is milled before being sent to wing assembly section. At right, tail section components are checked by Forrest Strnetz, assembly division head.

is simple—master switch on, fuel pump on and push the starter button. Cherokee uses full throttle for takeoff and climb and airplane was off the ground at 65 mph. in about 500 ft. Initial climb was at 90 mph. and at a bit less than 1,000 fpm.

The model has a fairly high noise level because Piper has not yet settled on what it considers proper soundproofing material and installation, and engineering section has a door fit problem that still is not ironed out, due to a bend at the top. Floor also is uncarpeted, using a plastic-type matting.

Leveling off at 2,500 ft., the Cherokee showed the high degree of stability in trimming for this regime that the design calls for. Hands off flight was possible after airplane accelerated to 122 mph. IAS. It was a warm day—60F—and airspeed trued out to 129 mph.

The Cherokee handles easily and it would be difficult to get into trouble on the landing, which was made from a 90 mph. final approach. Nose wheel is steered from the rudder pedals and both



THREE-VIEW of the Piper Cherokee shows the 7 deg. dihedral in wing. Airplane has a slight resemblance to the more expensive Comanche, sells for $9,995 in the standard version. Three wheels are of the same size for interchangeability and taxiing ease.

Latest Experimental Meteorological Satellite on Course, Thanks to Bell Scientists—to Aid in Weather Forecasting

THE DAY of operational weather satellites is one step closer with the orbiting of the National Aeronautics and Space Administration's Tiros II.

An on-the-job, working satellite, the TV-equipped Tiros II will take pictures of cloud cover and transmit them to earth for limited, experimental use in forecasting weather.

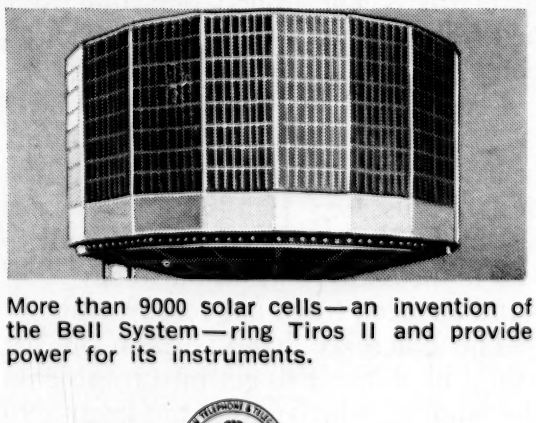
But despite its many instruments—TV cameras, tape recorders, solar cells and antennas—Tiros II would not be as useful if it were not in a nearly perfect circular orbit, made possible in large measure by the Bell Telephone Command Guidance System.

To provide accurate weather data, the satellite must be at an almost uniform distance from the earth at all times. Tiros II's orbit varies within extremely narrow limits as it constantly circles the earth.

Our Command Guidance System for the Tiros launching vehicle is a result of research and development by Bell Telephone Laboratories and production by Western Electric. This amazingly accurate system has scored many other successes in America's space program.

It has guided the successful Air Force Titan ICBM firings, and it helped make possible the first nose cone recoveries after flights of ICBM range. It also guided NASA's Tiros I and Echo I into their carefully planned orbits, and will be used in other forthcoming space probes and satellite launchings.

This Command Guidance System is one of a number of ways the Bell System is participating in the nation's space effort. The skills and knowledge called for in this pioneering activity are important assets in the country's defense.



More than 9000 solar cells—an invention of the Bell System—ring Tiros II and provide power for its instruments.

BELL TELEPHONE SYSTEM

flight and ground visibility is excellent due to large window areas.

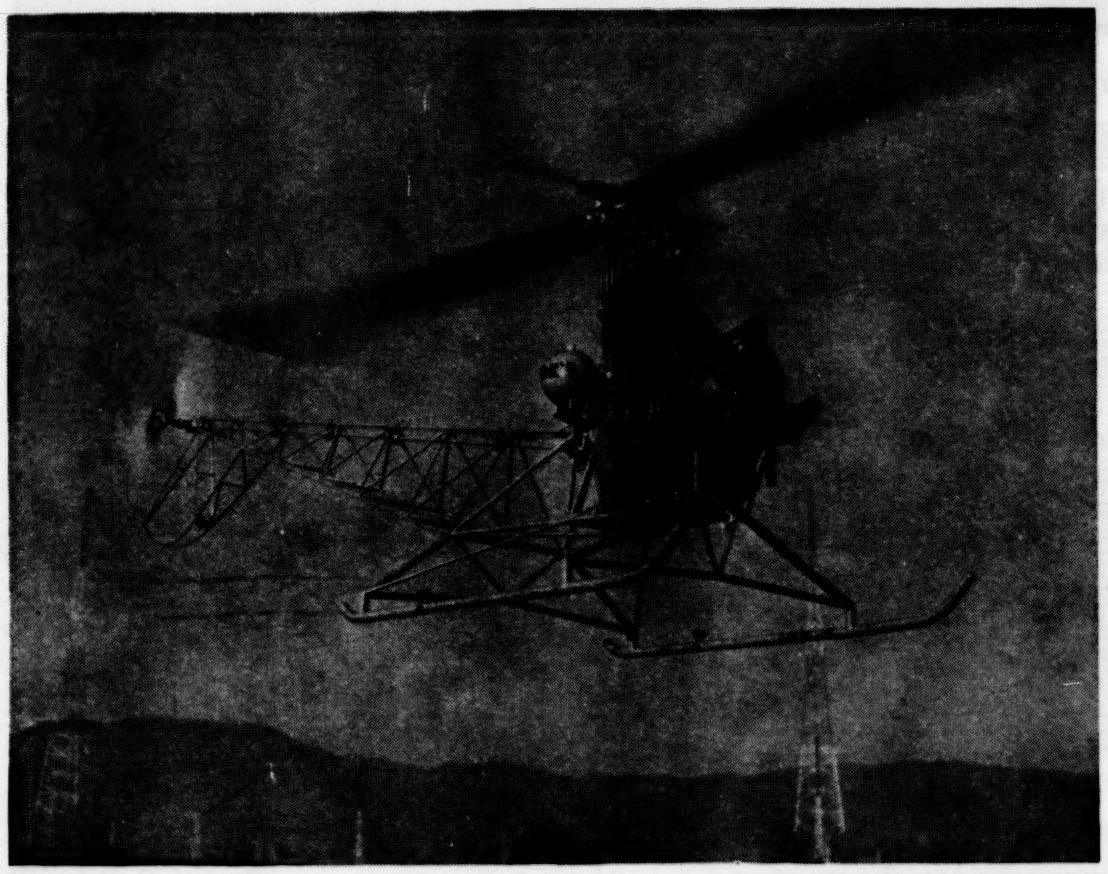
Interior was decorated in light colors, which Heffner feels has a definite effect on reducing pilot fatigue on long trips. Baggage compartment is large and rear cabin includes a shelf for more storage room. This Cherokee was fitted with a Piper AutoNav, and a Narco Superhomer aud AutoFlite are available; Heffner has been using AutoFlite on his test flights for more precise data-gathering.

Tlre AutoNav is a product of Piper's newest unit, the Vero Beach Electronics Division, headed by Peter H. Robeck. Division now is in an older building but eventually will move to new quarters.

Fifteen men and women—all trained on the job by Robeck and Hans Sylten, project engineer—assemble the Auto-Nav, a low cost, low frequency radio compass which sells for $495. It is standard equipment on all Custom, Super Custom and AutoFlite models of Piper single engine planes; weight is 5½ lb. installed.

Robeck said the Auto-Nav is an outgrowth of the Bird Dog, which Piper acquired in 1960 with acquisition of Aero Signal Laboratories, but the new unit has 50 times more sensitivity and twice the accuracy.

The division also includes an Electronics Development Laboratory where engineers now are working on design and development of an entirely new line of VHF transmitters and receivers for aircraft.



SECOND prototype of this Swiss-built helicopter, which flew for the first time in September, has now recorded 12 flight hours. It was demonstrated to experts from the Swiss Federal Air Office at Meyrin, near Geneva.

Swiss Helicopter Uses Fiber Blades

Geneva—Improved version of the first rotary-wing aircraft to be built in Switzerland, a single-seat, single-engine helicopter, was demonstrated recently to representatives of the Swiss Federal Air Office, Berne, at a small airfield at Meyrin, near Geneva.

The helicopter, X-HB-XVA, is powered by a 65 hp. Continental A65-8 reciprocating engine driving a two-blade rotor made of glass fiber with a plastic covering. Each blade is 11.48 ft. long and 11 in. wide. The craft is fitted with a Bell-type gyroscopic stabilizer. Its empty weight is approximately 576 lb. Gross weight, including pilot and 5½ gal. of fuel, is approximately 795 lb. At a cruising speed of 74½ mph., endurance is about 1¼ hr.

Robert Stierlin, 34-year-old mechanic for CERN (European Nuclear Research Center) at Meyrin, is responsible for the design and most of the construction work. Stierlin, a helicopter enthusiast since youth, spent some 4,000 hr. developing and building the present prototype. He says he has not built the aircraft with any commercial purpose in mind.

Roger Mercier, one of Stierlin's colleagues at CERN, helped him construct the airframe of both the first and second prototypes. Stierlin built most of the rest of the helicopter single-handed in a small shed at Meyrin.

Stierlin's first experimental prototype helicopter, powered by a French 40-hp. Salmson engine, was completed in 1954. He demonstrated it the same year at a private European helicopter competition at Saint Etienne, France, where it was awarded first prize.

Encouraged by recognition of his basic design, Stierlin began work on an improved second prototype to be powered by the Continental A65-8. This model made its first successful 30 min. tethered flight late in 1957, but untethered flights were only begun this fall. At present, it has totaled 12 flight hours.

Although Stierlin has logged only 32 flight hours in his two helicopter prototypes, he has been granted official permission to fly his craft in the vicinity of the Swiss Aero Club's Prangins airfield outside Geneva where the aircraft is based.

Flight Tests Start On Klemm Kl. 107D

Nabern, Germany—Klemm Kl. 107D, first executive aircraft of four-seat capacity to be built in postwar Germany, now is undergoing flight tests here prior to planned scheduled production scheduled to begin next spring. First flight was made Oct. 10.

Like its predecessor, the three-seat multi-purpose Klemm Kl. 107C, this latest version in the Kl. 107 series was developed by the Klemm-Bölkow group and will be produced under license here by Bölkow Appartebau Nabern GmbH., an associated company of Bölkow-Entwicklungen K. G., Munich, which markets the aircraft.

Designed specifically for business and private flying, the Klemm Kl. 107D is a single-engine low-wing monoplane of semi-monocoque wood construction. It has a spacious cabin with two side-by-side seats, a full-vision cockpit, a large baggage compartment behind the two rear passenger seats and the usual light-

Klemm Kl. 107D

Preliminary Specifications

Dimensions:	
Span	35.45 ft.
Length	27.22 ft.
Height	7.38 ft.
Wing area	165.70 sq. ft.
Weights:	
Empty weight	1,430 lb.
Oil and fuel	330 lb.
Baggage	88 lb.
Passengers	682 lb.
Gross weight	2,530 lb.
Performance without tip tanks:	
Maximum speed	158 mph.
Maximum cruising speed	143 mph.
Landing speed	53 mph.
Takeoff distance	1,033 ft.
Landing distance	918 ft.
Range	807 mi.
Fuel consumption	8.18 gph.

Picchio Four-Place F.15 Is Fully Acrobatic

Four-place Picchio F.15, shown here with German registration assigned to its purchaser, is one of first 10 production aircraft to be delivered. Others have been sold to buyers in Switzerland and Italy by Picchio manufacturer Procaer S.P.A. of Milan, Italy. Plane was designed to U. S. CAR Part 03, is fully acrobatic three-seater in utility category or a four-seater under normal requirements. Picchio has all-wood airframe with laminated plywood skin faced with thin layer of aluminum alloy for better resistance to atmospheric conditions and improved characteristics. Picchio cruises at 160 mph., was described in Aviation Week pilot report (AW Jan. 25, p. 94).

plane instrumentation and radio installation.

Maximum speed is quoted at 158 mph., cruise speed at 143 mph. Range is 807 mi.

Wooden Wing

The detachable cantilever wooden wing is of single-spar design with fabric-covered trailing edge section.

The landing gear is fitted with oleo-pneumatic shock absorbers and glass fiber reinforced plastic fairings. Its 7.93-ft.-wide wheel track enables the aircraft to take off or land on unprepared ground and grass strips. The brakes are operated hydraulically from the rudder pedals. Parking brakes are controlled by a lever on the instrument panel. Upon releasing the locking mechanism, the steerable tail wheel can be turned 360 deg.

Powerplant is a single air-cooled, four-cylinder 180-hp. Lycoming with an electric starter. Engine drives a variable-pitch propeller.

Two fuel tanks, each containing 26.41 gal., are located in the wing roots. Two auxiliary tanks located in the wing tips and containing 13.20 gal. each can be supplied as an optional extra.

Standard and de luxe models of the Klemm K1. 107D are available. Standard version is supplied with the normal flight instruments and engine maintenance tools; the de luxe model with extra VHF and navigation equipment as well as a wider range of flight instruments.

Optional extras include crop dusting equipment, wheel skis and a glider towing device.

A definite price has not yet been fixed, but the manufacturers expect the standard Klemm K1. 107D to sell for approximately $13,625, and the de luxe model for slightly more.

U. S. Business & Utility Aircraft Shipments

October, 1960

Make & Model	No. of Units	Net Billings
Aero Commander 500A, B	5	
560E	0	$866,000
680E, F	6	
720	0	
Beech Super 18	5	
Model 33 Debonair	4	
Model 35 Bonanza	18	$1,988,000
Model 50 Twin-Bonanza	0	
Model 65 Queen Air	4	
Model 95 Travel Air	9	
Cessna 150	57	
172	279	
175	9	
180	13	$4,622,000
182	18	
210	10	
310	18	
Lake LA-4	2	$45,000
Piper PA-18 Super Cub	27	
PA-22 Tri-Pacer	11	
PA-23 Apache	3	
PA-23 Aztec	12	$1,196,000
PA-24 Comanche 180	7	
PA-24 Comanche 250	17	
PA-25 Pawnee	5	
Totals	539	$8,717,000

Above shipments reflect model changeover period, which influences delivery schedules in the fall. October shipments are down 142 units from the same month last year and net billings are down $385,000 for the comparative period. Total shipments through October, 1960, include 6,197 units with total net billing value of approximately $123,390,000, which compares with 6,296 units valued at $106,693,000 for the same period last year.

First English-Based 500B Sold to Manufacturer

First Aero Commander sold for use in England has been purchased by Geoffrey Woods, of Colchester, Essex, for use in sales trips throughout Europe, Africa and the Middle East. Woods' company manufacturers ventilating fans and heat exchangers. Plane, a Model 500B, was flown to England from Bethany, Okla., by Peter Wellby, company pilot. Woods chose the 500B from available literature and will have his first ride in England.

Mexicans Fight Drug Traffic From Air

Mexico City—Mexican narcotic and health agencies have taken to the air to wage war against growers of marijuana who have developed clandestine plantations in rugged mountain gorges and slopes.

Using Piper PA-18 Super Cubs, the narcotics agents, headed by Capt. Enrique Soto Rodriguez, are striking at a source of supply estimated worth "hundreds of millions of dollars," and most of it is smuggled into the U. S. across 1,500 mi. of border.

The growers have since expanded from marijuana to poppies, which are processed into opium, cocaine and heroin.

The airplanes—six PA-18s, two Cessna 180s and a Cessna 310—are under command of Capt. Xavier Merino Arroyo, who trained the bush pilots and supervised PA-18 modification. Other planes are used mostly for freight and mercy missions.

Strut Beefup

Modification was a strut and fuselage beefup to meet high g forces encountered in turns and dives necessary to enter gorges where the narcotics fields usually are found. The planes also operate at high altitude (Mexico City is 7,400 ft. above sea level) and to guard against icing, the carburetor heat unit was enlarged.

Altitude is a constant problem. In a recent "Operation Volcano," the pilots flew from 14,000 ft. to 19,000 ft. (above sea level) on flights checking areas around two volcanos, Popocatepetl and Iztaccihuatl. The planes searched 1,000 sq. mi. in 24 missions, amounting to 86 hr. of flying time.

In this operation, the air crews and ground forces, mostly Mexican infantry soldiers, destroyed 21 metric tons of marijuana plants, worth $850,000 after processing.

Because a pilot doubted the PA-18's capability at extreme altitudes, Merino flew him to 23,000 ft.—without oxygen—to demonstrate that the plane could cross mountain peaks. Ordinarily, pilots take oxygen bottles on the 16,000-ft. missions.

Altitude Flight

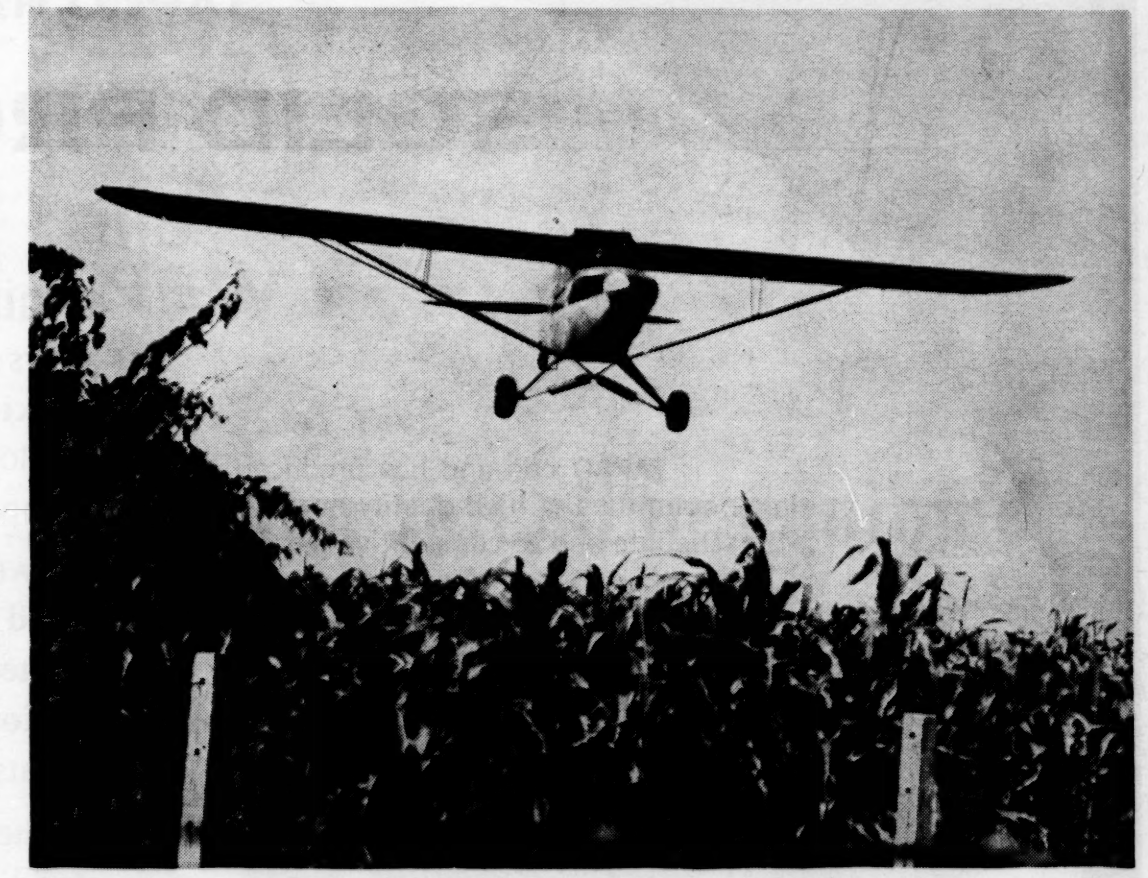
Merino said he spent about 25 min. at altitude after taking off from Mexico City. He said he reached 23,000 ft. after about 30 min., with the aid of thermals. Both men suffered slight anoxia, headaches and dizziness.

Effectiveness of the system was shown in "Operation Guanajuato," in which a 1,250 sq. mi. area was searched in 25 missions. The agents spotted 25 different marijuana patches and vectored ground troops to the scenes. Merino said the crops would have produced 5-6 tons of plants from which could have been gained 220 lb. of marijuana worth $150 lb. in the U.S. market. Eight traffickers were captured.

A third agency, Chief of the Federal Judicial Police, says it plans to build up its own six-plane fleet to combat drug trafficking from its branch of the government, which is responsible to the Mexican attorney general. Plane types have not yet been selected.

The other two agencies—Federal Narcotics Police and Department of Health and Public Assistance—are interested in use of helicopters and have evaluated a four-place Sikorsky S-51 and a Hiller 12-E in mountainside tests. Basic need, the agencies said, is a helicopter which can operate efficiently at altitudes 9-15,000 ft. above sea level, plus good high altitude takeoff and landing capability.

Actual attacks on plantations follow coordination of field reports from in-



PIPER PA-18 Super Cub makes low pass over Mexican field suspected of being used to grow marijuana. Trap between gear struts snags crop samples on low passes for evaluation by Mexican narcotics agents. Agencies use six Super Cubs for this work.

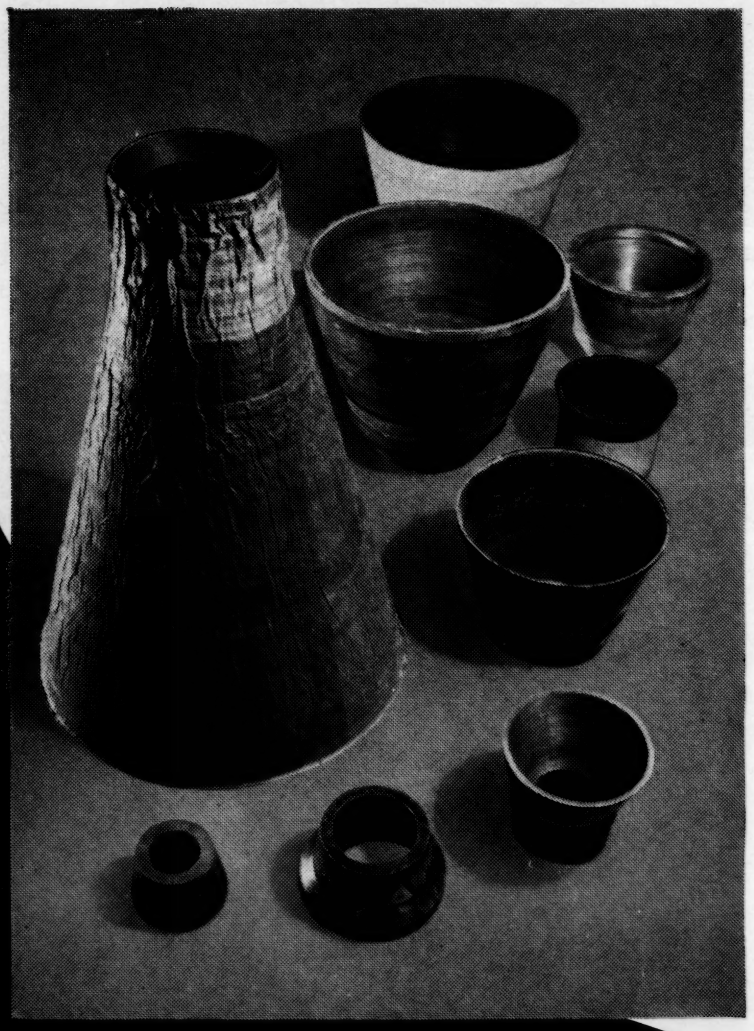
MEXICAN ground troops inspect marijuana plant found in field on mountainside.

TAPCO POW

TAPCO HAS ENGINEERING AND

SOLID PROPELLANT

TAPCO can and has produced large quantities of high quality nozzles, on schedule and at competitive prices. A few of the many configurations are shown below.



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These projects are handled by an outstanding project engineering team, capable of proceeding from concept through prototype production on a tight schedule. This team is supported by heat transfer specialists, dynamics analysts, structures and materials experts, a large plastics laboratory and an advanced high-temperature metallurgy laboratory.

Advanced projects at TAPCO offer excellent career opportunities for qualified engineers and scientists. Write Director of Professional Employment.

TRW

Stock Transactions

The Securities and Exchange Commission's Summary of Security Transactions and Resultant Holdings for the period Sept. 11 to Oct. 10, 1960, reported the following transactions by three executives of The Martin Co.: acquisition of 4,630 capital shares through exercise of option by William B. Bergen, officer and director, making a holding of 12,809; acquisition of 3,150 capital shares through exercise of option by Clarence W. Miles, director, making a holding of 3,150; acquisition of 1,736 capital shares by Earl R. Uhlig, officer, making a holding of 4,162. Other transactions for the period Sept. 11 to Oct. 10 include:

All American Engineering Co. Disposition of 400 common shares by Robert B. Cotton, officer, leaving a holding of 11,472; disposition of 200 common shares by Donald B. Doolittle, officer and director, leaving a holding of 6,724; disposition of 300 common shares by Chester G. Jones, officer, leaving a holding of 1,152; disposition of 2,000 common shares, his total holding held indirectly, by Harry W. Lunger, director (direct holding remains 8,240.)

Allegheny Airlines. Disposition of 100 common shares, his total holding, by Edwin I. Colodny, officer; acquisition of 100 common shares by Nelson B. Fry, Jr., officer, making a holding of 200; acquisition of $3,000 of 6¼% convertible debentures by Hamilton O. Hale, director, making a holding of $3,000; acquisition of $2,000 of 6¼% convertible debentures by Lawrence L. Stentzel, officer, making a holding of $2,500.

American Bosch Arma Corp. Disposition of 10,214 common shares, owned indirectly, by Charles Allen, Jr., director, leaving a holding of 40,457.

Ampex Corp. Acquisition of 150 common shares by James E. Brown, officer, making a holding of 850; acquisition of 200 common shares by Kenneth R. Rickey, officer, making a holding of 200; disposition of 1,000 common shares by Walter T. Selsted, officer, leaving a holding of 1,625.

Avco Corp. Disposition of 200 common shares by Frank S. Larson, officer, leaving a holding of 4,503; disposition of 4,000 common shares by A. B. Newton, officer, leaving a holding of 1,666.

Avnet Electronics Corp. Disposition of 4,000 common shares by Michael G. Kletz, director, leaving a holding of 10,072.

Chance Vought Aircraft. Acquisition of 250 common shares by Clifford E. Burt, officer and director, making a holding of 850; disposition of 400 common shares, his total holding, by Leonard F. McCollum, director.

Continental Airlines. Disposition of 200 common shares by Lawrence C. Ames, director, leaving a holding of 7,800; acquisition of $15,000 of 4¾% convertible subordinated debentures by Mark Kramer, officer, making a holding of $20,000; acquisition of $10,000 of 5¾% convertible subordinated debentures by Lawrence C. Ames, director, making a holding of $35,000.

Eastern Air Lines, Inc. Disposition of 2,200 common shares by T. F. Armstrong, officer, leaving a holding of 6,595; disposition of 520 common shares, his total holding, by B. Griffith, officer; acquisition of 100 common shares through exercise of option by Robert L. Turner, officer, his total holding.

General Dynamics Corp. Acquisition of 825 common shares, owned indirectly, by W. McCormick Blair, director, making a holding of 3,075 (direct holding remains 3,700); acquisition of 700 common shares by Robert P. Meiklejohn, officer, making a holding of 2,700; disposition of 3,400 common shares by Robert C. Tait, officer, leaving a holding of 5,000.

General Precision Equipment. Disposition of 100 preferred shares by Donald W. Smith, officer and director, leaving a holding of 700.

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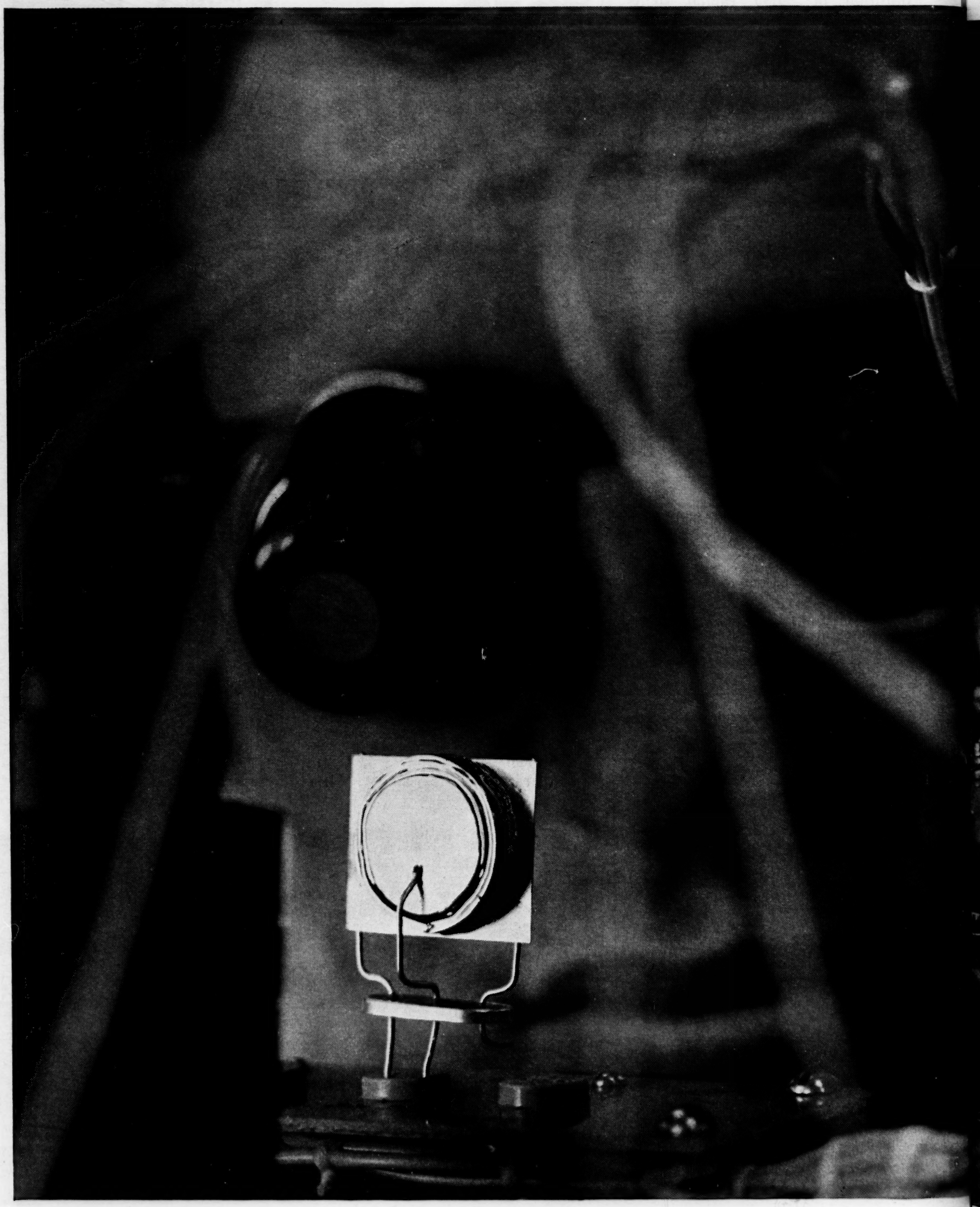
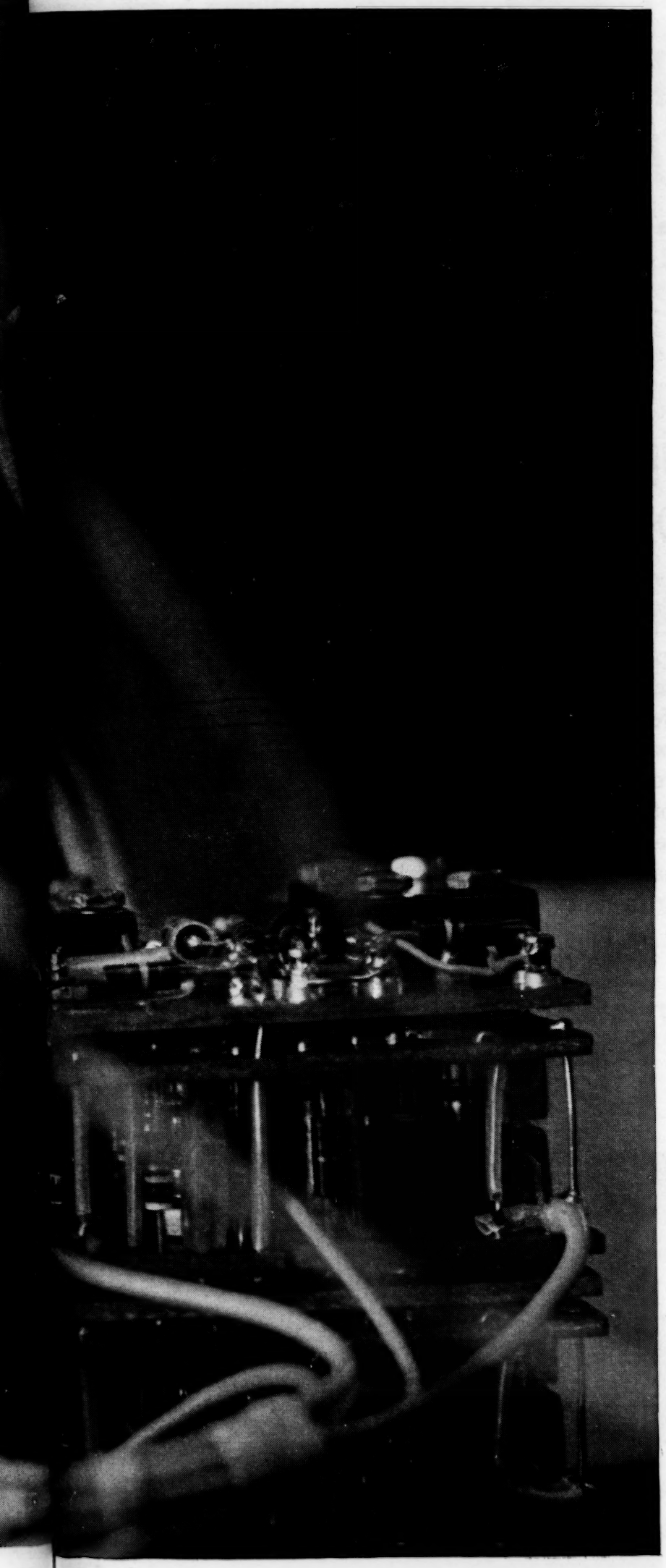


The mystery of radiation in space



Before man can safely travel into space, we must know more about the radiation he will encounter there. What kind it is. How much there is. Where it is.

A tiny Hughes radiation detector, housed in this electronics assembly, answers these questions. It is the most advanced detector yet developed—a thousand times faster reacting, smaller, more rugged than any other.

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Creating a new world with Electronics

HUGHES

Hughes Aircraft Company
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Los Angeles, California

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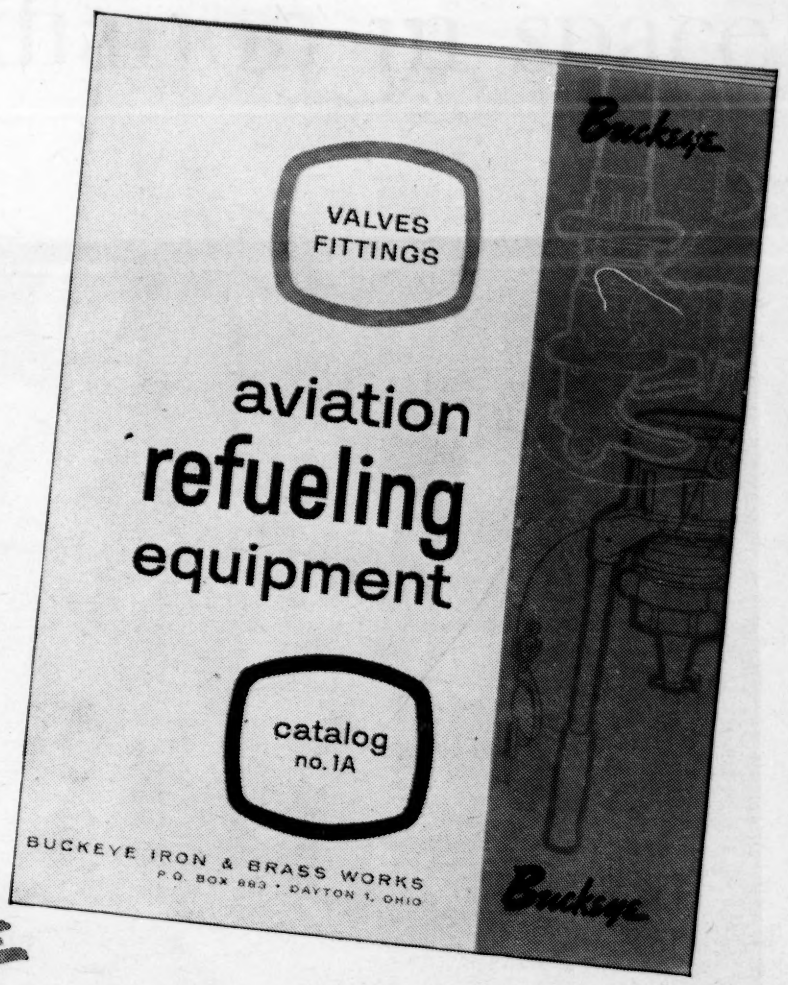

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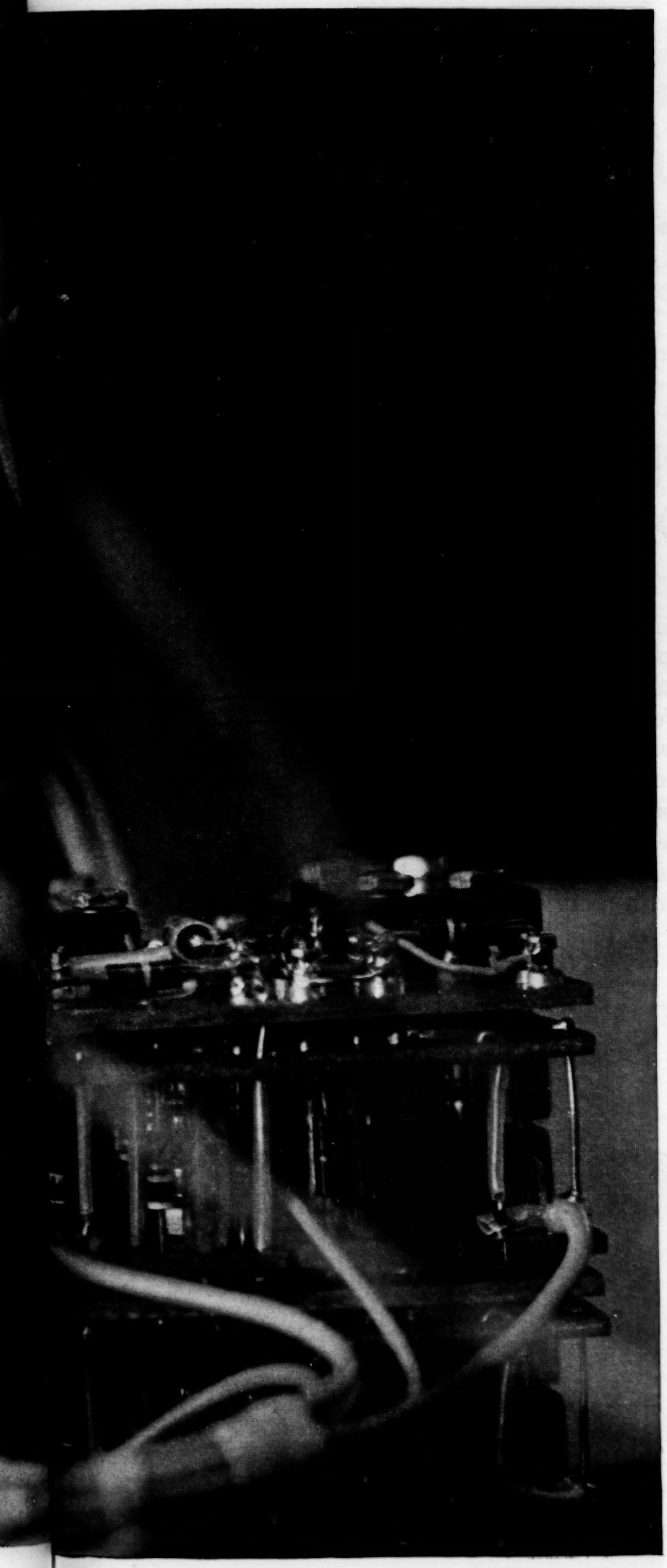
The mystery of radiation in space



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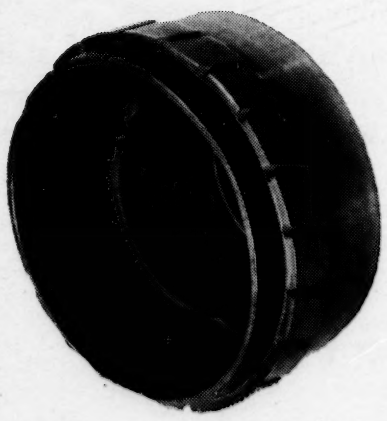

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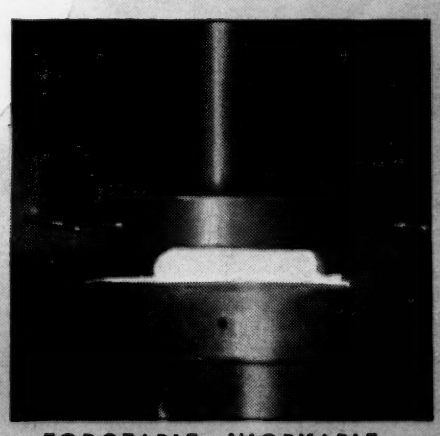
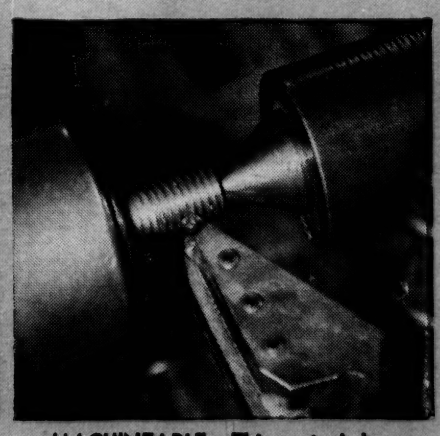
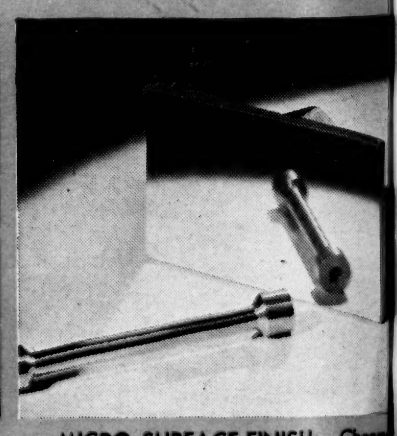


FORGEABLE, WORKABLE—Chrome Cerametalix can be forged and hot worked.



MACHINEABLE—This material can be precisely machined using conventional methods and equipment.



MICRO-SURFACE FINISH—Chrome Cerametalix can be polished to a micro-surface finish with standard machines.

WHO'S WHERE

(*Continued from page 23*)

Changes

Leroy R. Barr, general manager, Lear-Romec Division of Lear, Inc., Elyria, Ohio, succeeding **H. C. Andrus,** retiring.

David D. Terwilliger, chief engineer-systems, Precision Products Department, Nortronics Division of Northrop Corp., Hawthorne, Calif., and **David W. Pertschuk,** director of reliability and quality control.

Frank E. Maddocks, a senior member-business development staff, Arthur D. Little, Inc., Santa Monica, Calif.

Clifford F. Abt, manager, Research Department, Arma Division of American Bosch Arma Corp., Garden City, N. Y., succeeding **Dr. Bernard Litman,** now a member of Arma's newly created scientific staff.

Louis F. Heilig, manager of engineering-Shillelagh program, Weapons Systems Operations, Aeronutronic Division of Ford Motor Co., Newport Beach, Calif.

Goodrich-High Voltage Astronautics, Inc., Burlington, Mass., has established the following new departments and named the following managers: **Dr. A. Stuart Denholm**-Power Conversion Department; **Dr. Sam V. Nable**-Electrostatic Propulsion Department. Also: **Jason Weisman,** manager of operations for the firm.

Donald E. Garr, corporate director of engineering, Raytheon Co., Waltham, Mass.

Robert D. Schmidt, director of engineering, Telemeter Magnetics, Inc., Culver City, Calif. Also: **Jack Ogg,** Western regional sales manager, and **Graham Tyson,** director of marketing, Data Equipment Division.

Dr. Joseph V. Yance has been appointed to the research staff of the Operations Evaluation Group's Applied Science Division, Cambridge, Mass.

Ray W. Sanders, director of the newly organized Satellite and Space Laboratories, Space Electronics Corp., Glendale, Calif.

Edwin H. Spuhler, development manager-aerospace and military equipment, Aluminum Company of America, Pittsburgh.

Dr. Wilbur B. Davenport, Jr., chief staff scientist-Boston (Mass.) division of Developmental Engineering Corp., Washington, D. C.

Jack Durst, associate technical director, Pomona (Calif.) division of the Marquardt Corp.

Bryce I. MacDonald, Jr., manager-manufacturing engineering, Silicone Products Department, General Electric Co., Waterford, N. Y.

Charles F. Yost, assistant director, Materials Sciences, Advanced Research Projects Agency, Washington, D. C.

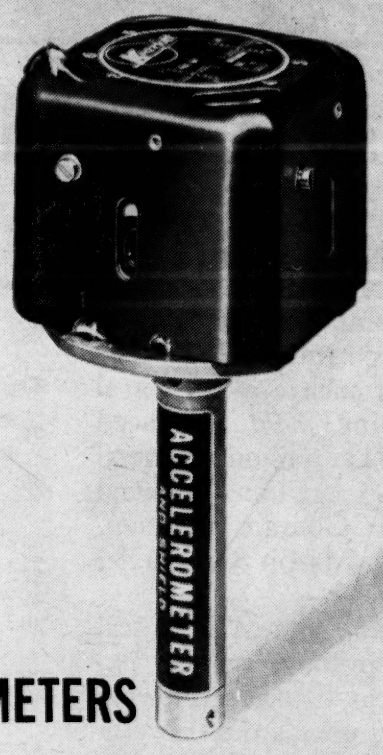
Robert Tomer, manager of information services, CBS Electronics, Danvers, Mass.

Milton Magid, senior staff engineer, Microwave Dynamics Corp., a subsidiary of Talley Industries, Inc., Plainview, N. Y.

John Walker, sales engineer, Allied Engineering and Production Corp., Alameda, Calif.

Carl C. McCallus, director of marketing, Viking Industries, Canoga Park, Calif.

Robert W. Middlewood, director of the newly established quality assurance branch, Lockheed's California Division, Burbank, Calif.



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CHARACTERISTICS:

TYPE NO.	SINGLE AXIS F2401	SINGLE AXIS 429037	TWO AXIS 326778-1
Range of Measurement	±20g	±25g	See above
Scale Factor (output)	5.0000 ma/g	5.0000 ma/g	
Operating Temperature	155°F ±5°F*	50°F and +160°F	
Threshold	5 x 10^{-7}g	Less than 2 x 10^{-7}g	
Zero Stability	±0.05 milliradian	±.00005g day to day	
Vibration	Up to ±10g peak from 20 to 2000 cps	Up to ±5g peak from 20 to 2000 cps	
Storage Temp.	−65°F to +200°F	−60°F to +170°F	
Scale Factor Variation	±.01% randomness	±0.01% randomness	
Excitation	6 volts, 3860 cps**	6 volts, 4000 cps**	3.4 volts, 4000 cps***
Natural Freq.	180 cps	210 cps	160 cps
Freq. Resp.	Flat to 250 cps	Flat to 160 cps	Flat to 100 cps
Shock	60 g's	30 g's	30 g's
Weight	4 oz.	7 oz.	2 lbs.

*Available for 180°F.
**Carrier frequency to 100 Kc may be used.
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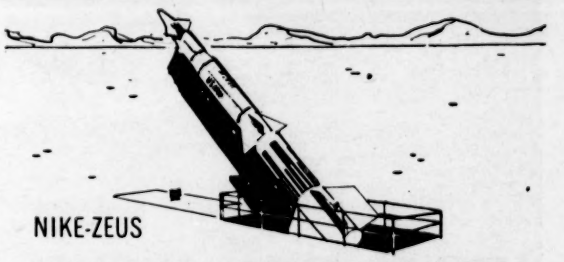
Defense Lists Top 500 R&D Awards

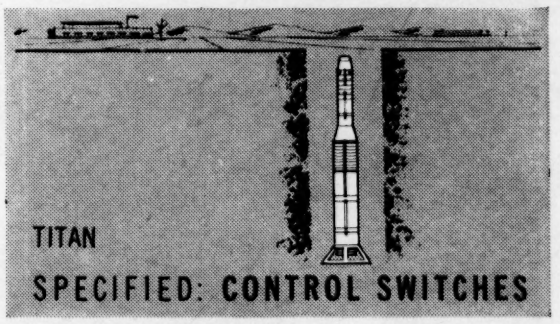
Washington—North American Aviation, Inc., with research, development and test awards of more than $567 million, headed 500 companies and agencies which received Department of Defense prime contracts for such work in Fiscal 1959. Next ranking were Lockheed Aircraft Corp., $511 million; General Electric Co., $395 million; General Dynamics Corp.'s Convair Division, $313 million, and Martin Co., $284 million.

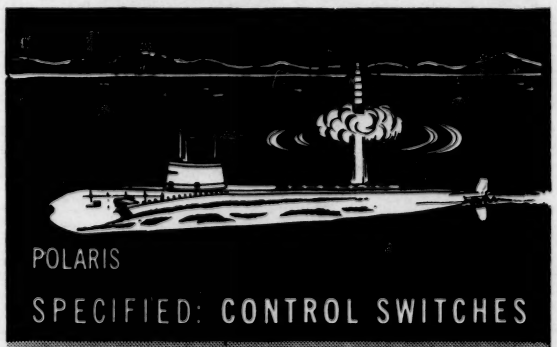
Total value of the awards in Fiscal 1959 was $5,246 million, against $4,077 million the year before. Following is a breakdown of companies, government agencies and nonprofit institutions by rank:

RANK	COMPANY	LOCATION	THOUSANDS OF DOLLARS
1.	North American Aviation	Los Angeles, Cal.	$567,744
2.	Lockheed Aircraft	Burbank, Cal.	511,430
3.	General Electric	Schenectady, N. Y.	395,057
4.	General Dynamics	New York, N. Y.	313,061
5.	Martin Co.	Baltimore, Md.	284,039
6.	Western Electric	New York, N. Y.	226,037
7.	Sperry Rand	New York N.Y.	208,951
8.	Douglas Aircraft	Santa Monica, Cal.	208,266
9.	Aerojet General	Cincinnati, Ohio	161,955
10.	Boeing Airplane	Seattle, Wash.	155,781
11.	Westinghouse Electric	Pittsburgh, Pa.	120,916
12.	General Motors	Detroit, Mich.	85,828
13.	United Aircraft	East Hartford, Conn.	78,651
14.	Thiokol Chemical	Trenton, N. J.	73,871
15.	Pan American World Airways	New York, N. Y.	71,380
16.	Raytheon Mfg.	Waltham, Mass.	62,180
17.	Space Technology Labs.	Los Angeles, Cal.	61,030
18.	Avco Corp.	New York, N. Y.	54,266
19.	American Bosch Arma	Hempstead, N. Y.	54,230
20.	Hughes Aircraft	Culver City, Cal.	49,480
21.	International Business Machines	New York, N. Y.	47,809
22.	Bendix Aviation	Detroit, Mich.	47,410
23.	International Telephone & Telegraph	New York, N. Y.	42,563
24.	Radio Corp. of America	Camden, N. J.	40,589
25.	Burroughs	Detroit, Mich.	37,795
26.	McDonnell Aircraft	St. Louis, Mo.	32,441
27.	Republic Aviation	Farmingdale, N. Y.	27,962
28.	Sylvania Electric Products	New York, N. Y.	27,401
29.	Collins Radio	Cedar Rapids, Iowa	24,929
30.	Goodyear Aircraft	Akron, Ohio	24,919
31.	Northrop	Beverly Hills, Cal.	23,086
32.	Hercules Powder	Wilmington, Del.	21,184
33.	Minneapolis-Honeywell	Minneapolis, Minn.	19,285
34.	Airborne Instruments	Mineola, N. Y.	18,725
35.	American Machine & Foundry	New York, N. Y.	17,997
36.	Bell Aircraft	Buffalo, N. Y.	17,885
37.	Thompson Ramo Wooldridge	Los Angeles, Cal.	17,403
38.	Fairchild Engine & Airplane	Hagerstown, Md.	17,047
39.	Callery Chemical	Callery, Pa.	14,943
40.	Temco Aircraft	Dallas, Tex.	14,541
41.	Olin Mathieson Chemical	New York, N. Y.	13,738
42.	Philco	Philadelphia, Pa.	13,025
43.	Litton Industries	Beverly Hills, Cal.	12,251
44.	Hayes Aircraft	Birmingham, Ala.	11,333
45.	Sangamo Electric	Springfield, Ill.	10,740
46.	Aeronutronic Systems	Glendale, Cal.	10,004
47.	Vitro Corp.	New York, N. Y.	9,835
48.	Sundstrand Machine Tool	Rockford, Ill.	9,712
49.	Hoffman Electronics	Los Angeles, Cal.	9,486
50.	General Mills	Minneapolis, Minn.	9,421
51.	Marquardt Aircraft	Van Nuys, Cal.	9,389
52.	Continental Electronics	Dallas, Tex.	8,861
53.	Motorola	Chicago, Ill.	8,377
54.	Land-Air	Chicago, Ill.	8,323
55.	Curtiss-Wright	Wood-Ridge, N. J.	8,261
56.	Hazeltine	Little Neck, N. Y.	7,808
57.	Rheem Mfg.	New York, N. Y.	7,569
58.	A C F Industries	New York, N. Y.	7,554
59.	Vertol Aircraft	Morton, Pa.	7,471
60.	Melpar	Falls Church, Va.	6,816
61.	Sanders Associates	Nashua, N. H.	6,642
62.	Grumman Aircraft	Bethpage, N. Y.	6,469
63.	Hallicrafters	Chicago, Ill.	6,138
64.	Air Products	Allentown, Pa.	6,056
65.	Northern Ordnance	Minneapolis, Minn.	5,500
66.	Atlantic Research	Alexandria, Va.	5,079
67.	Ryan Aeronautical	San Diego, Cal.	5,044
68.	Interstate Electronics	Anaheim, Cal.	4,982
69.	Control Corp.	Minneapolis, Minn.	4,965
70.	Magnavox	Fort Wayne, Ind.	4,944
71.	Librascope	Glendale, Cal.	4,930
72.	American Radiator	New York, N.Y.	4,746
73.	Chrysler	Detroit, Mich.	4,733
74.	Acoustic Associates	Mineola, N.Y.	4,595
75.	Cook Electric	Chicago, Ill.	4,380
76.	Astrodyne	McGregor, Tex.	4,316
77.	Stavid Engineering	Plainfield, N.J.	4,259
78.	Clevite Corp.	Cleveland, Ohio	3,691
79.	Universal Match	St. Louis, Mo.	3,585
80.	Bell Helicopter	Ft. Worth, Tex.	3,535
81.	Radiation, Inc.	Melbourne, Fla.	3,464
82.	Brown Engineering	Huntsville, Ala.	3,445
83.	Food Machinery & Chemical	San Jose, Cal.	3,409
84.	Little (A. D.)	Cambridge, Mass.	3,404
85.	Telecomputing Corp.	Los Angeles, Cal.	3,373
86.	Emerson Electric	St. Louis, Mo.	3,344
87.	Fairchild Camera & Instrument	Syosset, N. Y.	3,323
88.	Cubic Corp.	San Diego, Cal.	3,301
89.	Solar Aircraft	San Diego, Cal.	3,223
90.	Beech Aircraft	Wichita, Kan.	3,196
91.	Eastman Kodak	Rochester, N.Y.	3,188
92.	Texas Instruments	Dallas, Tex.	3,052
93.	Rohm & Haas	Huntsville, Ala.	3,024
94.	Polytechnic Research & Development	Brooklyn, N.Y.	2,982
95.	Garrett Corp.	Los Angeles, Cal.	2,964
96.	American Optical	Southbridge, Mass.	2,642
97.	Borg Warner	Chicago, Ill.	2,575
98.	Harvey Aluminum	Torrance, Cal.	2,507
99.	Continental Aviation	Detroit, Mich.	2,494
100.	LeTourneau (R. G.)	Longview, Tex.	2,426
101.	Loral Electronics	New York, N.Y.	2,400
102.	Edo Corp.	College, Point, N.Y.	2,299
103.	Daystrom, Inc.	Elizabeth, N.J.	2,280
104.	Aircraft Armaments	Cockeysville, Md.	2,257
105.	Gilfillan Bros.	Los Angeles, Cal.	2,252
106.	Ford Motor	Dearborn, Mich.	2,213
107.	Varian Associates	Palo Alto, Cal.	2,208
108.	Reeves Instrument	New York, N.Y.	2,143
109.	Dumont Laboratories	Clifton, N.J.	2,136
110.	Belock Instrument	College Point, N.Y.	2,092
111.	Emerson Radio	Jersey City, N.J.	2,046
112.	Litton Industries	College Park, Md.	2,043
113.	Combustion Engineering	Chattanooga, Tenn.	2,008
114.	Maxson (W.L.)	New York, N.Y.	1,960
115.	Electro-Optical Systems	Pasadena, Cal.	1,934
116.	Union Carbide	New York, N.Y.	1,887
117.	Dow Chemical	Midland, Mich.	1,870
118.	All American Engineering	Wilmington, Del.	1,853
119.	Coleman Engineering	Los Angeles, Cal.	1,848
120.	Lenkurt Electric Co.	San Carlos, Cal.	1,838
121.	Elgin National Watch Co.	Elgin, Ill.	1,805
122.	Barnes Engineering	Stamford, Conn.	1,767
123.	Tracerlab, Inc.	Boston, Mass.	1,733

RANK	COMPANY	LOCATION	THOUSANDS OF DOLLARS
124.	Flightex Fabrics	Cambridge, Mass.	1,724
125.	Allied Research Associates	Boston, Mass.	1,634
126.	Air Logistics	Pasadena, Cal.	1,632
127.	Technical Appliance	Sherburne, N.Y.	1,627
128.	Ampex Corp.	Los Angeles, Cal.	1,579
129.	U. S. Steel Corp.	Pittsburgh, Pa.	1,515
130.	TRG, Inc.	New York, N.Y.	1,483
131.	Minnesota Mining	Minneapolis, Minn.	1,469
132.	Hiller Aircraft	Palo Alto, Cal.	1,465
133.	Ceir, Inc.	Arlington, Va.	1,453
134.	Cleveland Pneumatic	Cleveland, Ohio	1,382
135.	Bulova Labs	Woodside, N.Y.	1,376
136.	Pacific Car & Foundry	Renton, Wash.	1,310
137.	Arinc Research	Washington, D.C.	1,258
138.	Esso Research & Engineering	Elizabeth, N.J.	1,254
139.	Piasecki Aircraft	Philadelphia, Pa.	1,213
140.	Flexonics Corp.	Maywood, Ill.	1,199
141.	Autometric Corp.	New York, N.Y.	1,189
142.	Aeronca Manufacturing	Middletown, Ohio	1,188
143.	Technical Operations	Burlington, Mass.	1,169
144.	Hughes Tool	Culver City, Cal.	1,139
145.	Perkin-Elmer	Norwalk, Conn.	1,130
146.	Telephonics Corp.	Hungington, L.I., N.Y.	1,115
147.	AFN Inc.	Los Angeles, Cal.	1,113
148.	Polarad Electronics	Long Island City, N.Y.	1,080
149.	Santa Barbara Research Center	Goleta, Cal.	1,077
150.	Ferrand Optical	New York, N.Y.	1,077
151.	Times Facsimile	New York, N.Y.	1,046
152.	Technitrol Engineering	Philadelphia, Pa.	1,046
153.	Kearfott Co.	Clifton, N.J.	1,044
154.	National Co.	Malden, Mass	1,040
155.	Goodrich, (B.F.)	Akron, Ohio	1,033
156.	Computer Control Co.	Babson Park, Mass.	1,014
157.	Electronic Communications	Teterboro, N.J.	1,013
158.	Underwood Corp.	New York, N.Y.	1,000
159.	Monsanto Chemical Co.	St. Louis, Mo.	992
160.	American Electronic Lab	Philadelphia, Pa.	987
161.	Edgerton Germeshausen & Grier	Boston, Mass.	983
162.	Radiation Engineering Labs	Maynard, Mass.	968
163.	Bliss (E.W.)	Canton, Ohio	964
164.	Eitel McCullough	San Bruno, Cal.	955
165.	Barnes and Reinecke	Chicago, Ill.	949
166.	Developmental Engineering	Washington, D.C.	942
167.	Standard Oil (Indiana)	Chicago, Ill.	924
168.	Bolt Beranek & Newman	Cambridge, Mass.	918
169.	HRB Singer	State College, Pa.	906
170.	Link Aviation	Palo Alto, Cal.	897
171.	Carrier Corp.	Syracuse, N.Y.	893
172.	Textron, Inc.	Belmont, Cal.	889
173.	Aerolab Development	Pasadena, Cal.	855
174.	Booz Allen Applied Research	Kenilworth, Ill.	843
175.	National Cash Register	Dayton, Ohio	833
176.	Firestone Tire & Rubber	Akron, Ohio	812
177.	Norman Engineering	Beverly Hills, Cal.	810
178.	McKiernan Terry	Dover, N.J.	802
179.	Stearns-Rogers	Denver, Colo.	799
180.	Pickard-Burns	Needham, Nass.	792
181.	General Electronics Labs.	Cambridge, Mass.	791
182.	Whirlpool Corp.	St. Joseph, Mich.	789
183.	Dynatronics, Inc.	Orlando, Fla.	781
184.	Plasmadyne Corp.	Santa, Ana, Cal.	771
185.	Kaman Aircraft Co.	Bloomfield, Conn.	768
186.	Hamilton Watch Co.	Lancaster, Pa.	768
187.	Reynolds Metals Co.	Richmond, Va.	766
188.	Experiment, Inc.	Richmond, Va.	765
189.	Allied Chemical & Dye	New York, N.Y.	761
190.	Wyandotte Chemical	Wyandotte, Mich.	755
191.	Dunlap & Associates	Stamford, Conn.	751
192.	White Motor Co.	Detroit, Mich.	739
193.	Laboratory for Electronics	Boston, Mass.	732
194.	Geotechnical Corp.	Dallas, Tex.	726
195.	American Cyanamid	New York, N.Y.	720
196.	Watkins Johnson	Palo Alto, Cal.	715
197.	Consolidated Electrodynamics	Pasadena, Cal.	713
198.	Federal Electric	Paramus, N.J.	710
199.	Chamberlain Corp.	Waterloo, Iowa	707
200.	Microwave Associates	Burlington, Mass.	694
201.	Beechcraft	Wichita, Kan.	690
202.	Planning Research	Los Angeles, Cal.	688
203.	Lear Inc.	Santa Monica, Cal.	686
204.	Applied Science	Princeton, N.J.	685
205.	Instruments for Industry	Mineola, N.Y.	684
206.	Gruen Applied Science Lab.	Hempstead, N.Y.	681
207.	EPSCO, Inc.	Boston, Mass.	679
208.	Eastern Precision Resistor	Brooklyn, N.Y.	676
209.	Continental Motors	Muskegon, Mich.	673
210.	Design Service Co.	New York, N.Y.	673
211.	Control Instrument Co.	Brooklyn, N.Y.	665
212.	Admiral Corp.	Chicago, Ill.	654
213.	Stauffer Chemical	Azusa, Cal.	649
214.	C.G.S. Labs	Ridgefield, Conn.	649
215.	United Electrodynamics	Pasadena, Cal.	644
216.	Doak Aircraft	Torrance, Cal.	640
217.	Telemeter Magnetics	Los Angeles, Cal.	635
218.	Cooper Development	Monrovia, Cal.	633
219.	American Marietta	Wheeling, Ill.	630
220.	Clark (David) Co.	Worcester, Mass.	630
221.	Alco Products	Schenectady, N.Y.	626
222.	Kennedy (D.S.)	Cohasset, Mass.	618
223.	Bermite Powder	N. Hollywood, Cal.	617
224.	Pennsalt Chemical	Philadelphia, Pa.	615
225.	Robertshaw Fulton	Greensburg, Pa.	614







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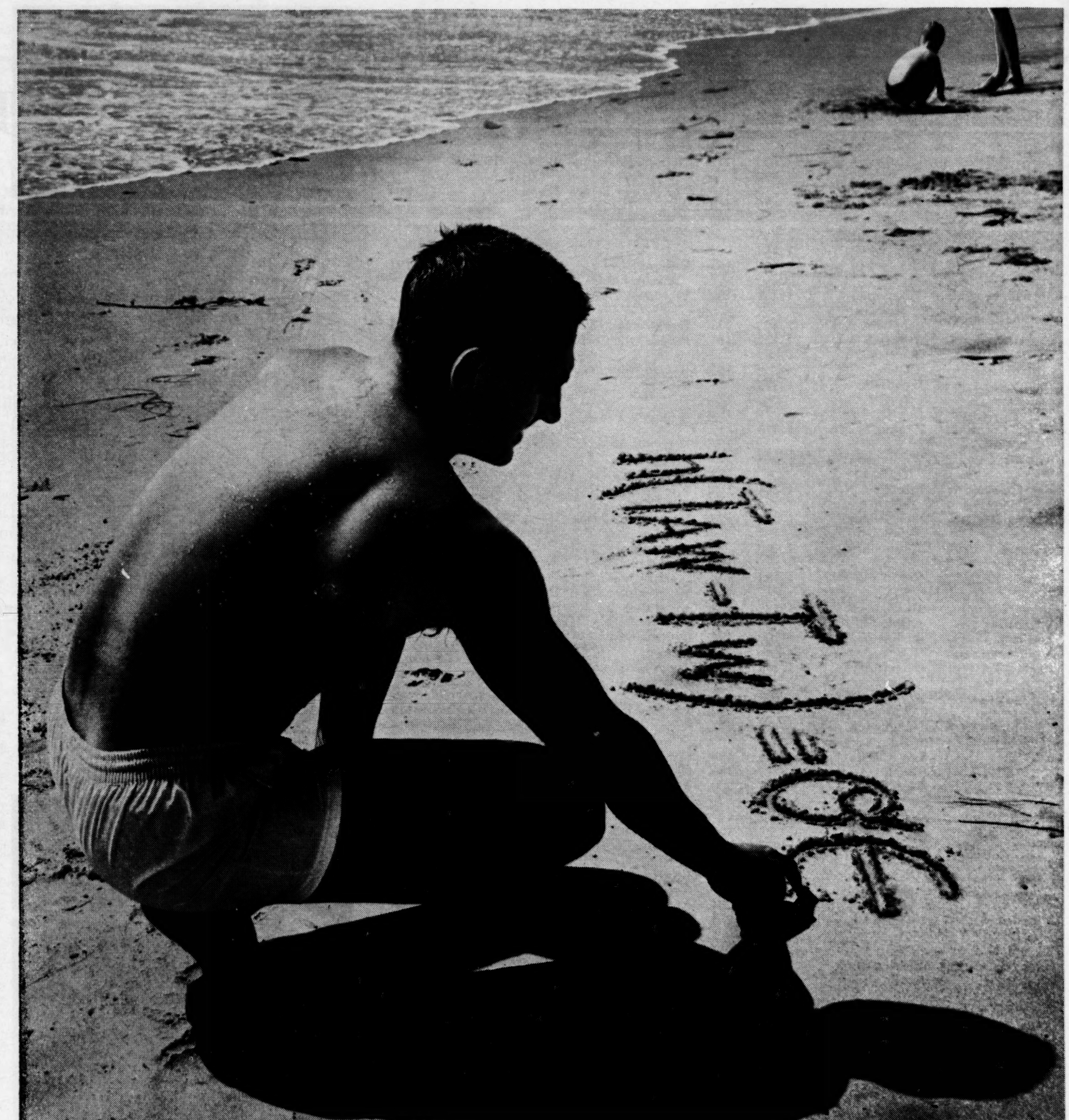

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356.	Raymond Engineering Labs	Middletown, Conn.	236
357.	Carborundum Co.	Niagara Falls, N.Y.	236
358.	Ingelhard Industries	Newark, N.J.	236
359.	Stevens (L. E.) Co.	Newport, Ky.	235
360.	National Scientific Labs	Washington D.C.	232
361.	Worthington Corp.	Harrison, N.J.	232
362.	Standard Mfg. Corp.	Dallas, Tex.	231
363.	Brush Beryllium	Cleveland, Ohio	231
364.	U. S. Testing	Hoboken, N.J.	231
365.	Fenwal, Inc.	Ashland, Mass.	229
366.	Gladding McBea	Los Angeles, Cal.	228
367.	Canoga Corp. of Calif.	Van Nuys, Cal.	227
368.	Zenith Radio	Chicago, Ill.	227
369.	Oster (John) Mfg.	Racine, Wisc.	226
370.	Ashland Oil Refining	Ashland, Ky.	225
371.	Eureka Williams	Bloomington, Ill.	224
372.	Aero Geo Astro	Alexandria, Va.	223
373.	Royal Industries	Alhambra, Cal.	222
374.	United Shoe Machinery	Beverly, Mass.	222
375.	Scope, Inc.	Fairfax, Va.	221
376.	Tenney Engineering	Union, N.J.	221
377.	Chesapeake Instrument	Shadyside, Md.	218
378.	Berger Bros. Co.	New Haven, Conn.	217
379.	Lionel Corp.	Irvington, N.J.	216
380.	Nuclear Corp. of America	Burbank, Cal.	216
381.	Teletype Corp.	Chicago, Ill.	215
382.	Scandia Manufacturing	Baltimore, Md.	215
383.	Stoddart Aircraft Radio	Hollywood, Cal.	214
384.	Giannini (G. M.) Co.	Pasadena, Cal.	213
385.	Research Chemicals	Burbank, Cal.	212
386.	Manufacturing Labs.	Cambridge, Mass.	210
387.	Documentation, Inc.	Washington, D.C.	209
388.	Schjeldahl (G. T.)	Northfield, Minn.	208
389.	Packard Bell Computer	Los Angeles, Cal.	208
390.	New York Air Brake	Boston, Mass.	207
391.	Geophysics Corp.	Boston, Mass.	207
392.	Stelma, Inc.	Stamford, Conn.	206
393.	Bomac Labs	Beverly, Mass.	205
394.	Professional Design	Agawam, Mass.	204
395.	Nordberg Mfg.	Milwaukee, Wis.	203
396.	Chu Associates	Littleton, Mass.	203
397.	Hoover Electronics	Timonium, Md.	202

GOVERNMENT AGENCIES AND NON-PROFIT INSTITUTIONS

RANK	COMPANY	LOCATION	THOUSANDS OF DOLLARS
1.	Mass. Institute of Technology	Cambridge, Mass.	$88,659
2.	Calif. Institute of Technology	Pasadena, Cal.	31,651
3.	Johns Hopkins Univ.	Baltimore, Md.	31,097
4.	Rand Corp.	Santa Monica, Cal.	13,236

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Digital Programming
Ground Communication and Surveillance Systems
Operations Research
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6.	Columbia University	New York, N. Y.	11,263
7.	Stanford Research Inst.	Menlo Park, Cal.	11,082
8.	Cornell Aeronautical Lab.	Buffalo, N. Y.	8,783
9.	California, Univ. of	Berkeley, Cal.	8,183
10.	Leland Stanford Univ.	Stanford, Cal.	7,744
11.	Armour Research Foundation	Chicago, Ill.	6,951
12.	Illinois, Univ. of	Urbana, Ill.	5,202
13.	New York Univ.	New York, N. Y.	4,879
14.	Princeton Univ.	Princeton, N. J.	4,746
15.	Chicago, Univ. of	Chicago, Ill.	4,364
16.	Battelle Memorial Inst.	Columbus, Ohio	4,032
17.	Texas, Univ. of	Austin, Tex.	4,007
18.	Harvard University	Cambridge, Mass.	3,570
19.	U. S. Dept. of Commerce	Washington, D. C.	3,484
20.	George Washington Univ.	Washington, D. C.	3,071
21.	Penn State Univ.	University Park, Pa.	2,916
22.	Minnesota, Univ. of	Minneapolis, Minn.	2,902
23.	Washington, Univ. of	Seattle, Wash.	2,704
24.	Ohio State Univ.	Columbus, Ohio	2,641
25.	Woods Hole Oceanographic Lab.	Woods Hole, Mass.	2,584
26.	Cornell Univ.	Ithaca, N. Y.	2,570
27.	Dayton, Univ. of	Dayton, Ohio	2,353
28.	New Mexico College of Agric. & Mech. Arts	State College, N. M.	2,092
29.	National Academy of Sciences	Washington, D. C.	1,984
30.	Duke Univ.	Durham, N. C.	1,923
31.	Franklin Inst.	Philadelphia, Pa.	1,900
32.	Inst. for Defense Analysis	Washington, D. C.	1,900
33.	Maryland, Univ. of	College Park, Md.	1,874
34.	Southwest Research Inst.	San Antonio, Tex.	1,718
35.	Pennsylvania, Univ. of	Philadelphia, Pa.	1,630
36.	Georgia Technical Research Inst.	Atlanta, Ga.	1,894
37.	Brown University	Providence, R. I.	1,345
38.	Midwest Research Inst.	Kansas City, Mo.	1,323
39.	Pittsburgh, Univ. of	Pittsburgh, Pa.	1,317
40.	Washington Univ.	St. Louis, Mo.	1,287
41.	Illinois Inst. of Technology	Chicago, Ill.	1,268
42.	Wisconsin, Univ. of	Madison, Wisc.	1,147
43.	Denver Univ.	Denver, Colo.	1,100
44.	Colorado, Univ. of	Boulder, Colo.	1,067
45.	Northwestern Univ.	Evanston, Ill.	1,057
46.	Carnegie Institute of Technology	Pittsburgh, Pa.	1,049
47.	U. S. Treasury Dept.	Washington, D. C.	1,015
48.	Syracuse Univ.	Syracuse, N. Y.	1,011
49.	Polytechnic Institute of Brooklyn	Brooklyn, N. Y.	976
50.	Analytic Services	Santa Monica, Cal.	968
51.	Utah, Univ. of	Salt Lake City, Utah	958
52.	Yale Univ.	New Haven, Conn.	952
53.	American Univ.	Washington, D. C.	908

RANK	COMPANY	LOCATION	THOUSANDS OF DOLLARS
54.	Stevens Inst. of Technology	Hoboken, N. J.	878
55.	Mellon Inst.	Pittsburgh, Pa.	837
56.	Alaska, Univ. of	College, Alaska	815
57.	Case Inst. of Technology	Cleveland, Ohio	782
58.	Texas A & M College	College Station, Tex.	767
59.	Wentworth Inst.	Boston, Mass.	749
60.	Smithsonian Inst.	Washington, D. C.	711
61.	Miami Univ.	Coral Gables, Fla.	628
62.	Rochester Univ.	Rochester, N. Y.	621
63.	U. S. Atomic Energy Comm.	Washington, D. C.	604
64.	Western Reserve Univ.	Cleveland, Ohio	596
65.	Catholic Univ. of America	Washington, D. C.	586
66.	Southern Calif., Univ. of	Los Angeles, Cal.	585
67.	Virginia, Univ. of	Charlottesville, Va.	567
68.	Arizona, Univ. of	Tucson, Ariz.	540
69.	Purdue Research Found.	Lafayette, Ind.	514
70.	Florida State Univ.	Tallahassee, Fla.	481
71.	Tufts College	Medford, Mass.	472
72.	American Inst. of Research	Pittsburgh, Pa.	465
73.	Rensselaer Polytechnic	Troy, N. Y.	458
74.	Vanderbilt Univ.	Nashville, Tenn.	453
75.	North Carolina, Univ. of	Chapel Hill, N. C.	445
76.	Mass. General Hospital	Boston, Mass.	441
77.	Oklahoma A & M	Stillwater, Okla.	429
78.	Notre Dame Univ.	South Bend, Ind.	429
79.	Florida, Univ. of	Gainesville, Fla.	417
80.	Southern Research Inst.	Birmingham, Ala.	406
81.	Northeastern Univ.	Boston, Mass.	394
82.	Georgia Inst. of Technology	Atlanta, Ga.	370
83.	Indiana, Univ. of	Bloomington, Ind.	354
84.	Rutgers Univ.	New Brunswick, N. J.	345
85.	Iowa, Univ. of	Iowa City, Iowa	342
86.	New Mexico, Univ. of	Albuquerque, N. M.	342
87.	Cincinnati, Univ. of	Cincinnati, Ohio	328
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Cessna 1960 Sales Show 2% Decline

Wichita, Kan.—Gross sales of $103,278,000 are reported by Cessna Aircraft Co. for the 1960 fiscal year ended Sept. 30, down 2% from the record high achieved by the company last year.

The decline was attributed to military program stretchouts, including deliveries of T-37B trainers and Boeing B-52 stabilizers. Its subsidiary, Aircraft Radio Corp., also experienced a reduction in military orders.

Business aircraft sales continued to show new highs and accounted for a total volume of $56,104,000, representing a 20% increase over last year and the highest level ever attained by Cessna.

The business plane sales increase was markedly influenced by introduction of the Model 210 single-engine airplane and expended export sales activity.

Export sales last year totaled $10,497,000 with a total of 709 units shipped abroad compared with $6,959,000 representing 494 units in Fiscal 1959, Cessna President Dwane L. Wallace reported. He noted that last year Cessna accounted for 47% of the total business plane unit market and 36% of its dollar volume.

Wallace expects that 1961 sales volume should improve over Fiscal 1960, although he said that military volume should decline in the coming year.

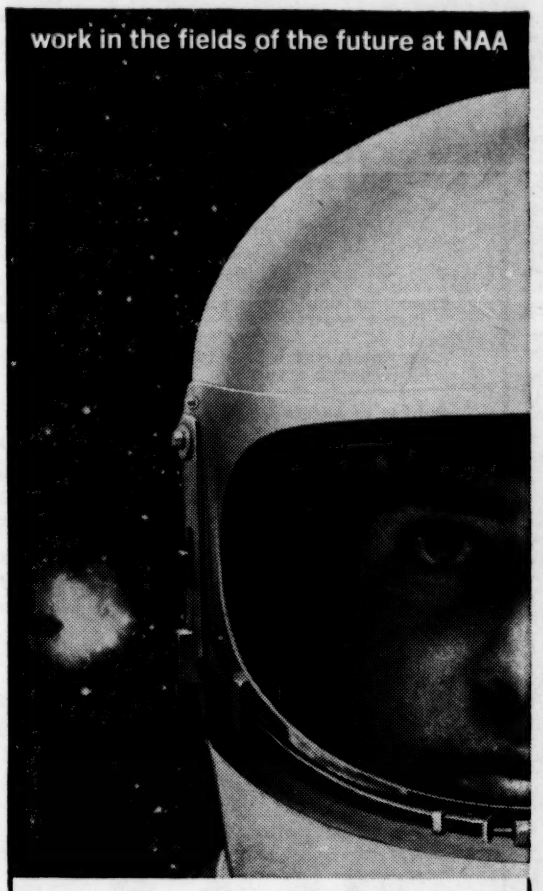
Financial Brief

Beech Aircraft had net earnings of $4,854,059 in 1960, an increase of 22.3% over the previous year. Sales totaled $98,873,800; business aircraft sales was $46,570,254 of that total.

Union Texas Natural Gas Corp. of Houston, Tex., has organized and financed Quantitron, Inc., a company that will develop products in the fields of applied physics, microwave electronics, information technology, quantum electronics, and space technology.

The Hallicrafters Co. had net sales for the first three months of Fiscal 1961 ended Nov. 30, 1960, of $11,683,000, a 48% gain over the $7,891,000 sales figure for the first quarter of last year. Earnings for the same period this year were $356,000, up 30% from last year's first-quarter earnings of $273,000.

Collins Radio Co. sales in the first three months of Fiscal 1961 were $53,341,464, the largest for any quarter in the company's history. Last year in this period sales were $42,003,394. Earnings for the first quarter of this year were $1,484,958 as compared with $2,034,317 for last year's first quarter.



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LETTERS

Atomic Bomb Carriers

In the Dec. 12 issue (p. 31) of your fine magazine we noticed an error in the caption accompanying the first photographs of the atomic bombs. In the last sentence it credits the Enola Gay with carrying both the Hiroshima and Nagasaki bombs.

The Enola Gay, which is in the National Aeronautical Collections and which will be restored in preparation for exhibit in the new National Air Museum Building, carried only the first bomb. The second one was carried by the B-29, Bock's Car, piloted by Maj. Sweeney.

It is so seldom that we can find a mistake in AVIATION WEEK that we had to take advantage of this opportunity!

PHILIP S. HOPKINS
Director
Smithsonian Institution
National Air Museum
Washington 25, D. C.

Fluorine Engines

Re: "Fluorine Rocket Fuel" letter, AW Nov. 28, p. 132.

Mr. Pilcher gives faint praise to the merits of fluorine rocket engines to the point of suggesting a program cancellation. Major decisions which implicate the national—if not the entire free world's—aerospace capability require detailed examination of all data, from the scientific to the congressional levels.

This brings into focus the need for dissemination of information: a charter which AVIATION WEEK has most competently undertaken.

First, a brief historical account of the fluorine rocket engine development program. Participants in this program have included industry, government and numerous universities. Some of the significant program mileposts (i.e., excluding chemical and materials fields) are as follows:

- 1949—first engine firing.
- 1953—firings in excess of 1,000-lb. thrust.
- 1955—fluorine stage R & D initiated.
- 1960—Bell announces 15,000-lb. thrust, regeneratively cooled, fluorine-hydrogen turbopump engine. Rocketdyne test fires "flight weight hardware" Nomad fluorine system (AW Sept. 19, p. 34).

Workable fluorine engines are available. Little can be stated clearly of the USSR interest in fluorine, although guarded statements contained in several Russian documents (e.g., "Fluorine, a Translation from Great Soviet Encyclopedia," Moscow 1955) indicate possible fluorine engine development.

Fluorine is an energetic oxidizer. But that all tankage and plumbing must be "lined" is not true. A 10-year mission may require material protection techniques, however, many metals and metal oxides are compatible for liquid fluorine service including several stainless steels and aluminum alloys. This is due to the fluorine initially attacking the metal and forming a tough oxide coating impervious to further corrosion. The best evidence of this fact is the successful development of fluorine-critical engine components such as injectors and pumps.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

The pure products of combustion from a fluorine/hydrogen engine are harmful to flora, fauna and homo sapiens, as are the exhaust gases from various acid system engines. Efficient techniques have been developed to render such poison gases harmless. The present safety record of all fluorine engine firing attests to this commendable development. Further, since all serious fluorine applications are proposed for upper stages and/or spacecraft, all future atmospheric fluorine engine firings will be limited to the controlled environment of static test cells. The prejudice against toxic fluorine engine exhaust gases may be somewhat likened to the early prejudice against the hazards of liquid hydrogen—which was subsequently shown to be safer than an equivalent barrel of gasoline.

The writer agrees that the lower stages of Saturn and Nova will never see fluorine service, and that nuclear systems are the next logical replacement for these large oxygen/hydrogen stages (see "Mobile Propellant Supply Systems Studied," AW Sept. 5, p. 68). However, spacecraft operations—which could include "upper stages"—involve missions, ground rules, etc., which are different from launch vehicle operations. There are many cases in which a fluorine system clearly exhibits superiority over other systems. Nor is this superiority based solely on the 5% increase in specific impulse over an oxygen/hydrogen system. It may be of interest at this point to reflect on the vast sum of money spent to increase the specific impulse of many present liquid and solid systems a similar amount.

Now to briefly examine the aspects of technical comparisons in light of the "next generation" manned spacecraft requiring a total velocity increment of several thousand feet per second. The difference between launch vehicle capability and the spacecraft minimal dry weight often leaves little room for spacecraft propulsion systems design, however, the following propulsion system factors become desirable if not mandatory: (1) high specific impulse, (2) low weight, (3) low volume, (4) multiple functions (including re-start), (5) reliable (system factor), (6) safe (crew factor), and (7) all within a 1965-67 system operational date. Present evaluations indicate items, 2, 3, 6 and 7 above tend to eliminate consideration of nuclear rockets. The major advantages of the fluorine over the oxygen system are as follows (approximate values):

A 5% increase in specific impulse, two-point increase in system mass fraction, 60% reduction in fuel tank volume, 20% reduction in oxidizer tank volume, hypergolic, comparable space storage and availability.

Note that system volume may further increase the vehicle dry weight owing to the increased structure (i.e., cabin or interstage structures) required to simply accommodate the increased system volume.

In conclusion, any system of propellants and engines must be exhaustively analyzed for merit and application prior to suspending its development. Fluorine represents one such system as it appears necessary and vital for future spacecraft operations.

J. W. DORSEY
The Martin Co.
Baltimore, Md.

Radiation Effects

The letter of Mr. Bill Haussler of Atomics International, which appeared in AVIATION WEEK on Oct. 31 (p. 114), was of great interest to this writer. The topic of radiation effects, and particularly the transient malfunctions which can be produced by nuclear explosions, has been under investigation at Hughes Nuclear Electronics Laboratory for some years, and indeed much of the recently published material referred to by Mr. Haussler was based upon work done in this laboratory.

During this same time period a great deal of attention has been devoted to analyzing the detailed nature of the nuclear radiation produced by a nuclear explosion, and to determining the type or types of laboratory equipment which can simulate these radiations with adequate accuracy.

For this simulation task, three principal criteria must be evaluated: (1) duration or time history; (2) energy or spectral distribution; (3) peak radiation rate. These are, of course, in addition to duplicating the nature of the radiation, i.e. gammas and/or neutrons.

One finds that no one machine is in existence which will adequately meet the three criteria. It is, however, possible by a combination of machines to produce a very adequate and useful simulation. The three machines which will collectively and adequately simulate the radiation from a wide gamut of typical nuclear weapons are (1) a gamma linac (microwave linear electron accelerator); (2) a Bare Critical Assembly (sometimes called "Godiva") as a fission neutron source; (3) a neutron linac as a fusion neutron source.

Many other machines or combinations of machines have been seriously considered for weapon simulators. Analysis shows that all of these fail either to match the time history or energy configuration of weapon radiation; hence, while they may be extremely useful tools for performing fundamental research in the nature of interaction between radiation and electronic systems, they cannot be considered adequate weapon simulators.

This writer is deeply interested in all phases of nuclear weapon radiation and its effects, and will welcome correspondence from others active in the field.

JOHN W. CLARK, MANAGER
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